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# ARMED FORCES CHEMICAL JOURNAL

ARMED FORCES CHEMICAL ASSOCIATION



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# ARMED FORCES CHEMICAL JOURNAL

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## COVER PHOTO

AT HOME WITH A MORTAR—Men of the 5th Regimental Combat Team fire 4.2 mortar into Communist-led North Korean positions in the Subok San Mountains of Korea, while their buddies use the opposite bank of the stream as a shelter for their camp.

## INDEX



## ADVERTISERS




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# EDITORIAL

This editorial is an expression of the opinions of the Editor. It does not represent a declaration of Association policy, since neither our membership nor our Directors have given expression to any policy declaration upon the subject. It is not an expression of any official policy of the Chemical Corps, and has not been submitted to them.

Our readers are invited to write their comments upon the subject to the Editor, and their views will be published, subject to space limitations.

In World War I toxic gases were used extensively in ground warfare by both sides. From the fact that this usage grew more extensive as the war progressed we may deduce that it was considered an effective tactical weapon.

During World War II toxic gases were used by neither side. The common explanation for this omission was that "poison gas" was looked upon as an inhumane weapon, that the Allied forces declined to use it unless in retaliation for its use by the enemy. It was eventually known that both Germany and Japan were convinced that the Allies were in a position to wage toxic warfare more effectively, defensively and offensively, than themselves; and that insofar as they could eliminate its use by not initiating it they were the gainer by its disuse. Their omission of its use was dictated by tactical, not moral considerations.

This editorial proposes to discuss and question the premise that the use of toxic gas in warfare is "inhumane" with relation to the use of other weapons which were not so classified.

Men have always used the most potent weapons of which they could avail themselves. The sword, the spear, the arrow and the firebrand evolved into the bayonet, the rifle, the tank, the high explosive shell, the flamethrower and the incendiary bomb. Every weapon was designed to disable or kill the enemy, or to destroy his means of making war. And every weapon killed or disabled more efficiently than its predecessor.

Along with the evolution of weapons into more deadly means of destruction, there appeared to have developed certain restraints and conventions in the conduct of war; a distinction between what was permissible and what was forbidden. Moral considerations no doubt

played their part in this tendency, but it is logical to suppose that selfish motivation and fear of retaliation can account for most of the amelioration in the terrors of war, since this trend was arrested and reversed in war as this generation has known it.

With the advent of modern weapons a nation's industrial installations became the primary bases from which they waged war, and the destruction of such bases a paramount military requisite for victory. As one cannot destroy the factories and industrial centers of a nation while sparing the civilian population, inevitably civilians found themselves sharing the hazards and the brutality of war.

War itself is certainly not a humanitarian enterprise! It is waged by seeking out and disabling or destroying the enemy and his military potential. The means employed are many and varied but all have one thing in common—their purpose is the capture, disablement or destruction of the enemy. The attempt to classify these means into the "humane" and the "inhumane" is an illusion.

Military effectiveness is the criterion of military weapons, not ethical considerations. As the purpose of a weapon is to disable or destroy the enemy, the more swiftly, surely and economically it accomplishes this result, the better the weapon.

Any other concept is a delusion and a fallacy.

A nation at war or facing war cannot afford to make decisions based upon delusion and fallacy. It is essential, therefore, that the American people attain a sound and realistic understanding of this concept of weapons. Today a great many Americans have accepted the premise that toxic gases, etc., are "horror" weapons—inhumane—and their use by our nation inhibited except in retaliation against their use by an enemy.

Has this concept and this attitude been reflected in our military planning and our military preparations? If, in an effort to "make the most" of our military expenditures we have failed to stock up to the fullest requirements in the matter of toxic weapons on the premise that such weapons "might not be used again, as they were not used in World War II", we may have made a major military decision on the basis of a fatally unsound assumption.

If it be accepted that we would use toxic gases only in retaliation, we have made a basic military decision on a moral ground that is not even sound as such. The result could be fatal if the enemy capitalized on our weakness. It could prove a fatal want of strength if we permitted the enemy to dictate our choice of weapons, basing his decision upon what was expedient for *him* rather than for *us*. Specifically, if America, today indisputably the strongest nation in the world in its chemical industry, should face an enemy whose chemical industry were inferior, should we permit such an enemy to elect NOT to fight such a war in chemical fields?

If the purpose of this editorial were merely to justify the use of toxic weapons it could be readily demonstrated that they tend to be more rather than less humane than weapons of comparable potency whose usage is accepted. Gas casualties vary in degree from temporary disablement to death, just as in the case of other weapons; actually a successful gas attack is more apt to take men out of action without causing death or permanent disability than most anti-personnel weapons. But the basic fact is that the more efficient any weapon is, the greater its "inhumanity". Hence, if humanity be accepted as the criterion of the use of a weapon, it is required that it be inefficient—the argument reducing itself to absurdity.

It is probable that few of our readers will fail to agree, substantially, with the conclusions reached in this editorial. But conflicting opinions are held by a great many people, largely because there has been too little public presentation of the facts. It is hoped that our members will be persuaded to attempt some measure of public education upon the subject. Specifically it is suggested that this topic be made the subject of discussion in our Chapter meetings, and that such discussions be passed on to the public for thoughtful consideration.

It is not too late to disabuse the public mind of the erroneous concept that the disablement or destruction of an enemy is less humane when effected by toxic weapons than by the use of high explosives, shrapnel, heavy calibre rifle and machine gun fire, the flamethrower, the incendiary bomb, or the guided missile.

Harold B. Rodier, Lt. Col., Cml.C.-Ret.

# SKY-SAILORS SLASH KOREA*

By LCDR. Matthew H. Portz, USNR
Navy Combat Correspondent

Chongjin, Pyongyan, Wonsan, Inchon and hundreds of other strange sounding names were unheard of by most Americans prior to the Communist invasion of the Republic of Korea on June 24th. Navy carrier based airmen were no exception. But soon after the United Nations' decision to stop this aggression they became as familiar as Springfield, Chicago, Kansas City or Anytown USA to the hard flying Panther jet, Corsair and Skyraider pilots.

Rapidly advancing Red forces were not long overrunning most of the usable air bases in Korea. The Navy was confronted with the problem of not only supplying the guns, ammunition and reinforcements to the United Nations forces hanging on in the Pusan perimeter, but to also neutralize enemy supply and communications facilities as well as render close air support to our ground troops.

When the shooting war started the Seventh Fleet, commanded by Vice Admiral Arthur D. Struble, USN, had one carrier, the 27,000 ton Essex class USS Valley Forge, present in the Far East. Wasting no time, its airgroup swung into action on July 3rd in the Pyongyang and Sariwon areas with a telling effect. This was a warning to the North Koreans of the highly mobile striking power of the carrier based air they were to feel during the coming months.

The carrier pilots' first days work accounted for two Yaks blasted out of the air and eight more destroyed on the ground. The first of hundreds of locomotive, rail yards and bridges, trucks and air installations to be destroyed by Naval airmen were scratched by the Valley Forge's first day's strikes.

They came back the next day with three full air strikes and four jet fighter sweeps. Five bus loads of Red troops at Ongjin withered under their fierce strafing attacks. Swinging on up the North Korean rail lines 12 more locomotives were destroyed, a troop train and one oil train were left burning and three more bridges were knocked out to round out an average days work.

Many of the "Happy Valley's" pilots were seeing their first combat, led by veteran section leaders with World War II air fighting experience behind them. It wasn't long before they all got the feeling of veterans and went about their jobs like any man in the states going about his job. This was the work for which they were trained!

*(Opinions expressed are those of the author and do not necessarily reflect those of the United States Navy Department.)

Hammering on the anvil of North Korea later July strikes of the Valley Forge helped annihilate the North Korean airforce by destroying 27 aircraft on the 18th and bagging 18 more on the 19th. Although this was by no means all the planes the Reds had, not many ever again took to the air to oppose our airmen after those dates with the "Valley's" airgroup. The new boys were now veterans in their own right.

During the latter strike the first Navy plane went down in combat in the Korean War when Lt. (jg) W. B. Muncie's fighter-bomber was hit by gunfire and crashed into the Yellow Sea. Muncie successfully climbed into his life-raft and after a wet two and a half hours in the drink was rescued by an amphibian airplane from a British carrier.

While the Valley Forgemen burned the North Koreans up and down the peninsula, three more flattops, the Essex-class USS Philippine Sea and the gallant little escort carrier, USS Badoeng Strait and USS Sicily, were on their way from the states to join in the action. In the meantime the Essex-class USS Boxer made a record breaking run from San Francisco to Japan in eight days and seven hours ferrying a load of airplanes for the Air Force.

By this time most of the airfields in South Korea had fallen to the invaders and our troops in the Pusan perimeter were sorely pressed for close air support. The four carriers cruising off the coast were just "what the doctor ordered," for the Corsairs and Skyraiders could be over the target in a matter of minutes after leaving the flattop's flight decks with enough fuel and ammunition to stay over the target for hours.

The Valley Forge and Philippine Sea planes were present in such numbers to continue striking at Red transportation and industrial targets and still render close air support to the troops. The little "jeep" carriers had Marine Corsair fighter-bomber squadrons aboard who were experts at the close air support work. All the Marine pilots were veterans of the last war, about 50% of them were graduates of the Amphibious Warfare School which gave them an unequalled understanding of the ground soldiers problems. A team like this one couldn't be beaten and it wasn't.

A typical flight during these action filled days found the carrier airmen flying so low into the Korean valleys that enemy infantry fired on them from the hilltops above

while they blazed trails through the Red lines for their ground buddies to follow. Napalm fire bombs, fragmentation bombs, rockets and machine gun fire accounted for thousands of Communists.

All three types of Navy planes in action in Korea were heavily armed instruments of destruction. The Corsair fighter-bomber carries three 1,000-lb. bombs and eight five-inch rockets and has four 20mm guns in her wings. The Skyraider dive-bomber carries three 2,000-lb. bombs and 12 five-inch rockets and has two 20mm guns in her wings, while the Panther jet carries two 1,000-lb bombs and six five-inch rockets as well as four 20mm guns.

The most feared single weapon used against the Red troops is the searing napalm fire bomb which is simply a mixture of gelling powder and gasoline in a dropable tank under the planes belly. When dropped it is fused to explode on contact burning anything it touches. It burns up oxygen from the air so fast that persons within 30 feet of the fire itself are suffocated. Forward air controllers report that the enemy usually stays in his holes when ordinary bombs are dropped or rockets are fired, but when napalm comes anywhere near his position he takes off and runs. The Communists have found that it has a similar deadly effect on tanks!

Although North Korean naval targets were scarce, they came in for their share of pounding by naval air as did land targets. One day's bag accounted for two corvettes and three tankers sunk, and nine corvettes heavily damaged. In addition, 12 power boats, a freighter and another tanker were damaged.

Throughout August the carriers rained tons of high explosives on the Communists and their supporting activities daily. On into September the naval flyers continued their relentless pounding as the tide of battle was to change radically in favor of the United Nations after the landing at Inchon.

For a week prior to D-day planes from fast carrier task force 77 under the command of RADM E. C. Ewen, USN, and from the "jeep" carrier task group, commanded by RADM R. W. Ruble, USN, blasted at the Seoul-Inchon area and air strips within a radius of 100 miles while cruisers and destroyers poured their shells into pillboxes and artillery installations in the Inchon harbor area.

On D-day, September 15th, the big carrier's pilots and the Marine airmen from the little carriers provided an aerial cap for the landing and close support of the Marine troops as directed by the ground controllers with the troops ashore. More enemy troops, vehicles and gun emplacements throughout the landing radius were smothered with fire.

The Inchon landing was such a complete surprise to the Reds that they didn't get their defenses organized


FUEL FOR THE FIRES IN KOREA. A Marine "Corsair" night fighter's auxiliary gasoline tank is filled with Napalm, the dreaded gasoline-jelly mixture that proves an effective weapon against the N. K. Commies. Note: Jury-rigged 55 gal. tanks and compressor mounted on bomb trailers to facilitate handling at this advance fight base in Japan. Left to right: Sgt. Morton P. Gold, Washington, D. C.; T/Sgt. John H. Zoller, Jamaica, N. Y.; Cpl. Brady (m) Kelley of Memphis, Tenn.

until our troops reached Seoul. Even there they didn't hold long, and the columns of the now disorganized North Koreans both to the north and south of the Inchon-Seoul area were literally chewed to bits by the blasting guns and bombs of the Naval and Marine pilots. The mobility of naval forces, both surface and air, was paying off in the beginning of the end of the Communists in Korea.

Whatever exit from the battle front the North Koreans tried to use found them looking into the smoking muzzles of the guns of the carrier planes. Resistance pocket after resistance pocket was neutralized by the close supporting planes. As fast as the Reds moved in tanks to oppose our men on the ground, napalm would be plunked on them from the air with its usual disastrous results to the recipients. Soon there weren't any more tanks to bring up. The Reds were in rout.

Marine Corsairs bomb and strafe Communist-led North Korean troops in the hills somewhere in Korea.

Late afternoon strikes on September 20th from the "jeep" carriers were told by the forward air controllers to destroy a heavy Red troop concentration on the south bank of the Han river west of Seoul. Flight after flight of the Corsairs lobbed flaming napalm, bombs and rockets into the Communists. The enemy troops were so heavily concentrated that the airmen couldn't have missed if they'd tried. Unfortunately for the Reds they had holed up in an oil storage area, for intense black smoke was soon billowing up to over 8,000 feet in the air and was so thick that later flights from the carriers had to come in on instruments.

The next morning survivors of this attack filtered out onto the flatland on the airport across the Han from Seoul. The forward air controller with our ground troops spotted the Communists shifting from uniform into civilian clothes through his binoculars. He immediately ordered a nearby flight of Corsairs, led by Lt. Col. N. J. Anderson, USMC, in for the kill. The first pass cleaned out two large groups of the fugitives with napalm. Repeated strafing attacks finished off the rest.

The pilots reported back aboard the carrier that the controllers could see everything the Reds were doing. "When they tried to slip away by a quick change, we shot everything we had at them," they exclaimed.

Skyraiders and Corsairs from the Essex class carriers caught a column of 280 trucks racing reinforcements to the beleagered Communists. So much napalm and high explosive was poured on them that only about 50 managed to escape with the coming of darkness.

No story of the air war in Korea would be complete without mention of a new weapon of war, the helicopter. Many pilots alive and fighting today owe their lives to these busy little machines and their valiant pilots, who daily at the risk of their own lives picked up downed airmen from behind enemy lines, the sea or any other difficult position in which they may have fallen.

Only three minutes after crashing into the sea from the deck of the Boxer, which had returned to join her sister carriers on Inchon D-day, Ens. James Brogan, a Corsair pilot, was back aboard ship thanks to the helicopter.

While taking off for a strike at the Communist's, Brogan's engine failed and his Corsair fell into the sea ahead of the onrushing carrier. When the plane struck, its gas tank exploded enveloping that spot of sea in flaming gasoline. The Ensign somehow managed to free himself from the sinking plane and avoid most of the flames. Within seconds after he hit, a hovering helicopter, piloted by Lt. G. D. Haines, USN, picked him up. Ninety seconds later he was safely back on the Boxer with minor injuries. Total elapsed time—three minutes!

As the fighting moved past Seoul and deep into enemy territory, targets for the ranging carrier airmen were principally the fleeing Reds and their equipment. When the North Koreans dared stop to regroup and resist, the Navy and Marine planes were there to start them running again. Occasionally a locomotive or bridges, that managed to escape before, were pounded to destruction. Even though strong organized resistence was scattered, it was reassuring to our troops to have the carrier based planes close at hand, when needed.

October brought cold weather, snowstorms and fewer targets for skysailor guns, but Naval air was still on hand making the way easier for our groundmen mopping up Communist remnants. Another big carrier, the USS Leyte, joined her sisters in the fighting to overwhelm any spark of fight left in the Communists.

The Korean War has once again demonstrated the mobility and flexibility of hard working and fast moving carrier task forces. When the fighting was tough and the United Nations troops were crowded into the little Pusan beachhead without airfields, the carriers came to help drive the Communists back into North Korea. The "end run" at Inchon was sparked by carrier air leading the mobile amphibious force which changed the course of the war.

Seven-tenth of the earth's surface is water—a highway for carriers. The United States Navy stands ready to bring the weight of its carrier might anywhere over these highways should there be more Koreas.

In summing up the accomplishments of his airmen VADM Charles T. Joy, USN, commander of the Naval Forces in the Far East said, "Whatever praise I can give these boys cannot express our appreciation nearly as well as the expressions made so often by the front line forward air controllers when they tell the pilots, "You have neutralized the enemy positions. Our troops are moving in now!' "

Leatherneck all-weather twin-engine fighter, laden with Napalm, rockets and guns, roars out to hammer crumbling North Korean enemy.

Marine air-ground team really loves each other! During the fight for Kimpo Airfield, Lieutenant John V. Hanes piloting a Marine Corsair fighter-bomber hit by enemy fire, had to land. His infantry friends pushing the enemy back signalled him to land. And he got a warm reception from Leatherneck ground troops after he rolled down the runway—the first Corsair pilot to come in.

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# Hell Bombs Away!

# THEY DON'T LIKE "HELL BOMBS" NAPALM+GASOLINE="HELL BOMBS"

By Earle J. Townsend, First Lieutenant, Cml. C.*

Recently a newsman remarked to the writer, "Well, the Chemical Corps rode to fame in World War II on the merits of the 4.2 mortar. Now, in Korea, the Corps is getting the glory through Napalm."

Most certainly when the official histories of the present United Nations police action in Korea are written, especially the section covering the first five months of the conflict, the words "Napalm" and "fire bombs" will get more than just passing mention. Of all the complex pieces of war machinery that were used in Korea between last June and November, Napalm proved to be one of our most tellingly effective weapons.

On October 15, the *New York Herald-Tribune* brought public attention to this fact with a lengthy story on Napalm topped by a two-column head, reading, "Napalm, The No. 1 Weapon in Korea."

News about the effectiveness of the Chemical Corps' weapons being used in Korea has been sparse in the Office of the Chief Chemical Officer. However, through interviews with returning observers and scanning of the newspapers, we of the Chemical Corps and our allied industries have been able to keep tab on how our products were doing in the Far Eastern war zone.

The Pacific Edition of the *Stars and Stripes*, dated November 24, answered the question of when and how Napalm was first used in the Korean action.

Napalm was first used against the North Koreans three days after they crossed the 38th parallel in their abortive drive for Pusan. Although the name of the pilot who dropped the first "hell bomb" was not recorded in the story, it was Captain Richard E. Smith—now known as "Napalm Smith" to his buddies in the 8th Fighter-Bomber Wing of the Far Eastern Air Force—who was the first "braumeister." Captain Smith, a native of Sacramento, California, and the Ground Training Officer for the 8th, was one of the few men in Japan who knew how to brew the jellied petroleum, load it, and make proper use of it. His "field-assembled" bombs were jettisonable fuel tanks with a hand grenade attached as an igniter.

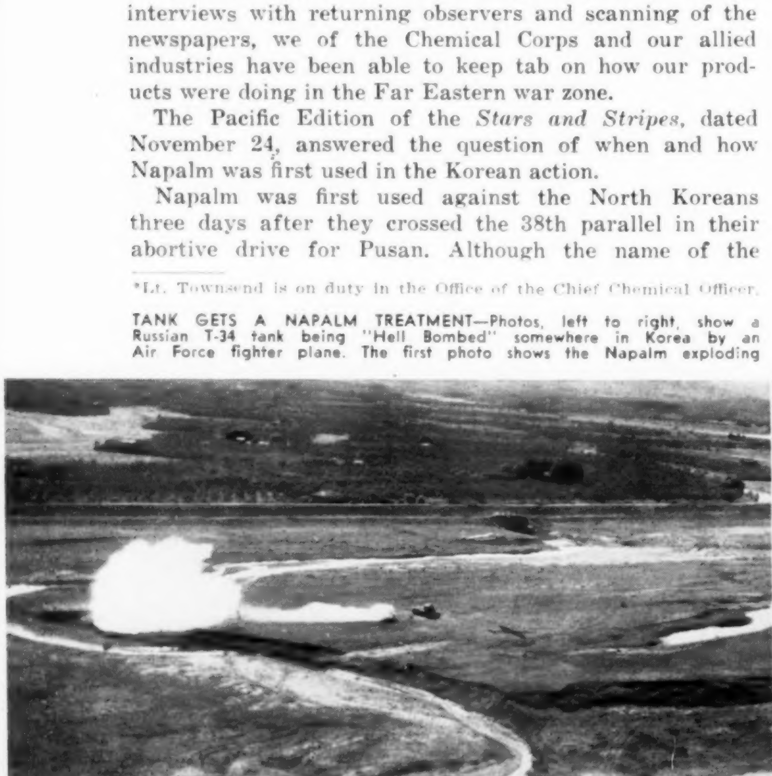
Probably the appearance of the Napalm "fire bombs" caused as much consternation among the North Korean Communists as did the first appearance of fire weapons among the enemies of the Grecian Empire hundreds of years ago.

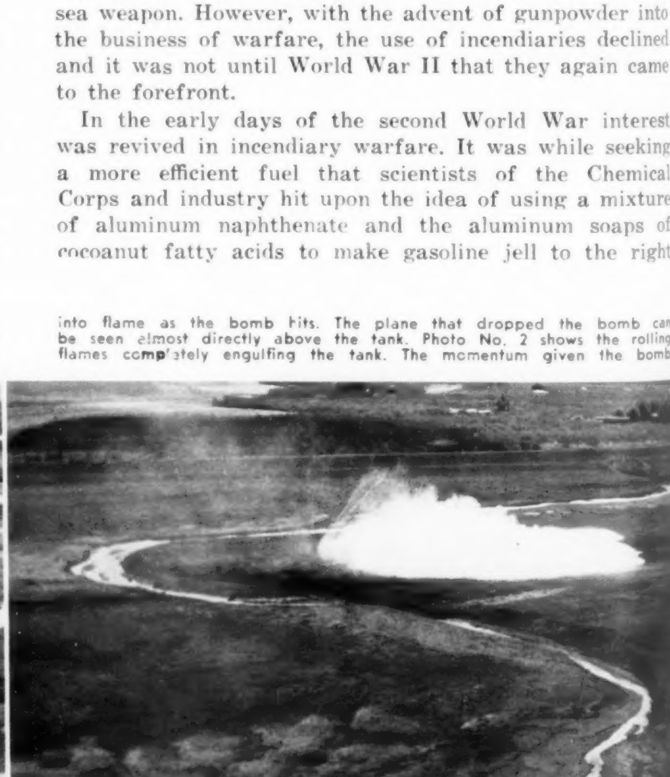
The Chinese discovered gunpowder in the period 1000-2000 B.C. Prior to that time, the Greeks had introduced the use of flaming oil as an effective land and sea weapon. However, with the advent of gunpowder into the business of warfare, the use of incendiaries declined and it was not until World War II that they again came to the forefront.

In the early days of the second World War interest was revived in incendiary warfare. It was while seeking a more efficient fuel that scientists of the Chemical Corps and industry hit upon the idea of using a mixture of aluminum naphthenate and the aluminum soaps of cocoanut fatty acids to make gasoline jell to the right

*Lt. Townsend is on duty in the Office of the Chief Chemical Officer.

TANK GETS A NAPALM TREATMENT—Photos, left to right, show a Russian T-34 tank being "Hell Bombed" somewhere in Korea by an Air Force fighter plane. The first photo shows the Napalm exploding into flame as the bomb hits. The plane that dropped the bomb can be seen almost directly above the tank. Photo No. 2 shows the rolling flames completely engulfing the tank. The momentum given the bomb





consistency for use in flamethrowers, both portable and mechanized. This naturally led to the idea of filling bombs with the jellied gasoline for use against certain types of construction. The word "Napalm" is derived from the two basic ingredients of the white granular powder. "Nap" comes from the napthenic acids, and "palm" from the cocoanut fatty acids. (EDITOR'S NOTE: *For a more detailed history of Napalm, see Dr. Hollingsworth's article elsewhere in this issue.*)

During the latter stages of World War II, Napalm made its appearance on all battle fronts. But, it was used most effectively against the Japanese and earned an early reputation as a good all-purpose munition. It flushed the enemy out of caves and hidden fortifications, it burned jungle hideaways and field installations, and set acres of flimsy construction afire on the Japanese homeland. It was an air as well as a ground attack weapon.

In the Korean conflict, Napalm has become principally an air-to-ground weapon, mainly because ground action moved backwards and forwards over the Korean landscape too swiftly for foot troops to call upon the support of flamethrowers, except in occasional circumstances. But the number of jellied gasoline "hell bombs" that have rained out of the heavens on the Communists has risen to astronomical figures. Adding to any confused estimates that could be made is the fact that, in addition to the hundreds of tons of regular 100-pound Napalm bombs shipped into Korea by the Chemical Corps, the Air Force made thousands of "fire bombs" of their own to drop during missions.

It's a simple matter to mix some Napalm powder in with a barrel of gasoline, let it "brew" for 24 hours, then pour it into a 150-gallon jettisonable fuel tank and head for any target that might present itself. These range-extension tanks are generally filled within 10 to 15% of capacity. For instance, during the first five months of the conflict, the Chemical Corps provided the Air Force alone with nearly two million pounds of Napalm powder. For jelling 150 gallons of gasoline, anywhere from nine to twenty-one pounds of Napalm would be used, depending upon the consistency required. On a 150-gallon basis, this would mean the Air Force could brew enough jellied gasoline for more than 100,000 "hell bombs."

Consider this news item from the *Stars and Stripes:* "The largest fire bomb raid of the Korean war was staged on November 10, when FEAF Bomber Command unleashed 85,000 incendiary bombs on military targets of the key North Korean communications and supply hub of Sinuiju."

Reports from officers who have been in Korea and are now back in the States, indicate that practically every fighter-plane that has flown into the Korean air has carried at least two Napalm bombs, either field-made or regularly manufactured. This was true whether the plane belonged to the Air Force, Navy or Marines. Weighing in the neighborhood of 1,500 pounds each, two droppable wing tank bombs are a full load for any fighter plane.

During late October and early November, the press often reported that pilots returning from the front remarked about the lack of "targets of opportunity." Maybe this can be partially blamed on carrier-based pilots grabbing off more than their share of opportunity targets to insure against having to drop their "hell bombs" in the sea before returning to their ships and creating fire hazards on the flat tops. In the first five months of the conflict, prime opportunity targets for aircraft were tanks and trains.

At the Pentagon not long ago, Lt. Col. Wes McPheron, one of the Army's combat radio reporters who had just returned from a three months' tour of Korea, told newsmen the Korean warfare has proven conclusively in his opinion, that Napalm is the most effective anti-tank weapon in the world—outside of our own tanks when they have a marked fire and mobile superiority over the enemy's vehicles.

"Napalm is the real answer to tanks, as anybody in Korea will tell you," Lt. Col. McPheron said. "The new bazookas and the new aircraft rockets will do the job all right, and they have destroyed lots of Communist tanks, but you have to get a fair hit on your tank with either of them for a kill." This remark made the officers and newsmen attending the briefing session prick up their ears. Until then the information had been only of the devastation visited upon the North Korean tanks by the new anti-tank weapons that had been hurriedly rushed to the front for their first combat usage last June when the Northerners crossed the 38th parallel. This Napalm as an airplane anti-tank weapon presented a new angle. There was plenty of interest when Lt. Col. McPheron continued.

"With Napalm, it doesn't matter whether you hit the tank or not, so long as your bomb is in the general

by the fast-flying plane makes the flames roll along the ground from the original point of impact. Photo No. 3 shows only a smouldering hulk of a tank still surrounded by jellied-gasoline flames, while a dark cloud of smoke hangs over the scene. Photo No. 4, taken several minutes after the bombing, shows the tank still burning and completely destroyed. —Department of Defense Photos.

AWAITING DELIVERY—A pile of states-side made Napalm bombs (center of photo) awaits transportation to an Air Force base from the Inchon supply depot for further delivery to the North Koreans. In the foreground may be seen two airplane jettisonable fuel tanks with which the Air Force makes their own "home-made" Napalm bombs.

—U. S. Army Photo.

vicinity," he said. "All that is necessary is for the spattering jellied gasoline to get on the tank and envelop it in flames. When the fire dies down and the smoke clears away, the black and gutted tank is as dead operationally as the crew aboard it."

When a Napalm bomb hits the ground, its flaming liquid spreads over a pear-shaped area about 30 yards wide and 90 yards long. Burning with a 1,500 degree heat, it sets aflame anything it touches and all that is nearby. Near misses of objectives mean little. Tanks have been missed by as much as several yards and yet set aflame, either by the intense heat generated by the burning gasoline, or through the rolling momentum given the flames by the bomb's drop from the plane. Instances have been reported where one bombing run has accounted for two and three tanks which were traveling in a close column.

During Lt. Col. McPheron's briefing, Army tank and ordnance experts agreed with him that Napalm had proven the most outstanding single weapon employed in the Korean operations. They also pointed out that it is one of the simplest and most economical of all weapons, since the "fire bomb" frequently consists of nothing more complicated than a droppable airplane wing tank filled with the highly inflammable jelly. Its use against trains has also proven phenomenal. No estimate can be made of the thousands of dollars worth of materiel or the number of lives lost through the "hell bombing" of Communist trains. Pilots have told newsmen that they like to catch a train when it is on a curve. Then, by dropping their Napalm missiles on the inside radius of the curve next to the train, they could do more damage than would be possible in a dozen strafing runs.

Referring again to the *Stars and Stripes*, an October issue told of a pair of Marine pilots who played a cat-and-mouse game with a freight train on the East coast, South of Wonsan. The engineer pulled his train into a tunnel before the planes could get close enough to do any damage. Every time he'd start to move the train out of the tunnel, the two pilots would pepper the entrance with their machine guns. Finally, they made it appear as if they were tired of the game and flew off over a hill. When the train pulled out of the tunnel completely, they came in from behind after circling the hill. The lead pilot dropped his Napalm "present" about three cars back of the engine, while the rear man hit the tail end of the train. Their report was "Scratch one Commie train."

The fire bombs also took their toll of personnel, especially when a fighter pilot with a couple of Napalm bombs under his wings could catch a convoy of trucks filled with troops out where he could get at them. Attacks against truck assembly areas or convoys were the same as those against tanks. Near-misses were just as devastating as direct hits.

The threat of fire from the skies had a demoralizing effect on North Korean troops, the bombs proving almost as effective against rifle-carrying soldiers as tanks. This was particularly so in terrain where troops were entrenched and virtually immune to any other form of attack. Again we rely upon Lt. Col. McPheron for a first hand report.

"In such cases, it was not even necessary to get the clinging, burning gasoline-jelly on the enemy to kill him," he said. "The heat generated in the wide area by such a bomb is enough to kill personnel exposed to it."

The above resultant effect was noted by the Infantrymen and Marines in the South Pacific during World War II, when they pointed flamethrowers at Jap positions and pulled the trigger. But this use of gasoline jelly from airplanes against ground soldiers of the enemy was something out of the ordinary.

The demoralizing effects of "hell bombing" upon ground soldiers can be cited in two news items from *Stars and Stripes* telling of North Korean troops waving white flags of surrender as pilots hovered their Napalm-laden planes over them. Both instances were reported in October. In the first case, the pilots of four F-51s spotted several groups of 50 or more North Koreans along the ridge overlooking a West coast strongpoint. At the time, UN troops were in the vicinity. The pilots dropped a couple of "hell bombs" and saw the remaining Communists run into nearby buildings. As they came in for another bombing run, the pilots saw white flags of surrender flying from the houses. In the second case, two fighter pilots blasted a convoy with Napalm and rockets and then headed for a small group of Communists who had seen the death-dealing raid from a nearby hilltop. As the planes approached the hill, a white flag was displayed by the enemy and the pilots subsequently reported "captured 12 North Korean prisoners while flying at 250 m.p.h. and without firing a shot." In both instances it was indicated that UN troops took over the prisoners

after they had been contacted by radio and planes had stood guard to make sure the North Koreans remained "captured."

The Marines added their own individualistic touch to this new type of warfare in mid-November when Captain Frank H. Presley of San Diego, California, spotted ten camouflaged North Korean artillery pieces in a cave mouth near Chosin reservoir. After several passes during which the flight's pilots blasted the cave entrance with rockets, according to *Stars and Stripes*, they finished up the demolition with a bomb. Results: total destruction of ten field pieces and their crews.

The Fifth Air Force, claimant to the title of being the first American command to hit the North Koreans after they crossed the 38th, didn't have time to light any candles on their ninth anniversary cake in September. Instead, reported *Stars and Stripes*, they lit things up among the North Korean troops with Napalm. In fact, on Sunday, September 17th, just prior to the anniversary date, the 5th's pilots staged a "Napalm Day." Flying F-51s and F-80s, the airmen made 172 sorties, covering the 8th Army front with deadly jelly-like fire bombs, and hitting anything that looked like a military target.

But, while the air use of Napalm has been the more spectacular news out of Korea in regards to Chemical Corps products, our other weapons have also been playing a big part in the ground warfare.

Although the 4.2-inch mortar is no longer a Chemical Corps weapon exclusively, we still maintain an active interest in it. When the 4.2 became a basic Infantry weapon following World War II, the Ordnance Corps became responsible for its procurement and supply. And, although this weapon has not played as spectacular a part as it did in the hills of Italy under the operation of Chemical troops, it received considerable press mention during the early part of the Korean conflict.

One reason why news about the 4.2 is hard to find is due to the fact that it is now designated merely as a "heavy" mortar. However, some of the newsmen apparently think enough of the weapon to use its familiar "4.2" tag. One of these writers is Associated Press' Bem Price, who had the following news story in the *San Francisco Chronicle* on November 12:

> KOTO, Korea, Nov. 10 (Delayed)—I revisited a Marine 4.2 mortar company today.
>
> I checked up on the guys I had known just one week ago.
>
> "The major?" they said. "Wounded."
>
> Down the list of the others the answers too often were, "dead ... dead ... wounded pretty bad ... wounded, not too bad ..."
>
> The night of November 3, when the Chinese Communists hit them, was one hell of a night, on the word of First Lieutenant Gordon Vincent of Gardner, Mass., and he is a man who rarely uses profanity.
>
> Vincent, a reservist called to active duty only a few weeks ago, now is company commander.
>
> The Marines since have advanced in their drive towards the Changjin reservoir, but this mortar company is full of stories of that bad night when the Chinese came charging down the hills and across a river bed.
>
> There was a young Negro corporal, Ray Pope of Lebanon, Ky., who fired a mortar as it was never intended to be fired. The 4.2 was never intended to be fired at an elevation of less than 45 degrees, but the Reds were so close he cranked it down to 33.5 degrees, a much flatter trajectory.
>
> He got off two rounds before the base plate kicked out of place ...

Price's story goes on to cite the individual heroic deeds of that fierce night of hand-to-hand combat.

On October 14, the Army Times paid tribute to the Chemical Corps' "Piece of stovepipe" when it told of the record of a fast moving 1st Cavalry Division mortar squad which knocked out seven enemy field pieces, two tanks, and later killed 200 North Koreans. "During a three-day period," the story reads, "the platoon to which this mortar squad is assigned knocked out 14 enemy field pieces and four tanks, but one gun crew was credited with destroying half of the weapons and tanks with a 4.2 mortar." The area where this action took place was not described.

The Corps' famed white phosphorous triple-threat munition (incendiary, screening, anti-personnel) has also received notices for the part it is playing. WP-filled grenades, rockets and shells have constantly been used by spotter planes to mark targets for bombing craft as well as for artillery fire on enemy positions. A photo released by the Far East Air Force Command early in November credits a spotter plane crew with even having knocked out a gun position when their WP rocket marker made a direct hit. Tankmen have also shown a preference for using WP shells for marking locations for artillery bombardments.

In the fighting around Seoul, where the North Koreans used the city's drainage ditches and conduits for cover, the Marines found an efficient means of combining WP grenades and rifle fire. An Acme Press photo gave a graphic description of this method of street fighting when it showed 1st Division Marines, who had trapped 20 Communists in a drainage ditch under a street, firing into one end with rifles and tossing a WP grenade into the other end.

During the first five months of the conflict, flamethrowers did not play too big a part. After the North Korean invasion and when the fighting was South of the 38th parallel, most of the enemy trenches seemed to be located on ground which could be attacked with Napalm bombs from fighter planes and other conventional weapons, observers have reported. But when the UN forces crossed the 38th parallel going North, they encountered the fixed positions which the North Koreans had constructed during the years preceding the invasion. Some of these positions could only be subdued through the use of the portable flamethrower. A hurry-up call brought these weapons up from the rear areas for use by Infantrymen, Marines and ROK forces. Their effectiveness, used in support of rifle and artillery fire, was shown in the short length of time these positions remained tenable for the North Korean Communists.

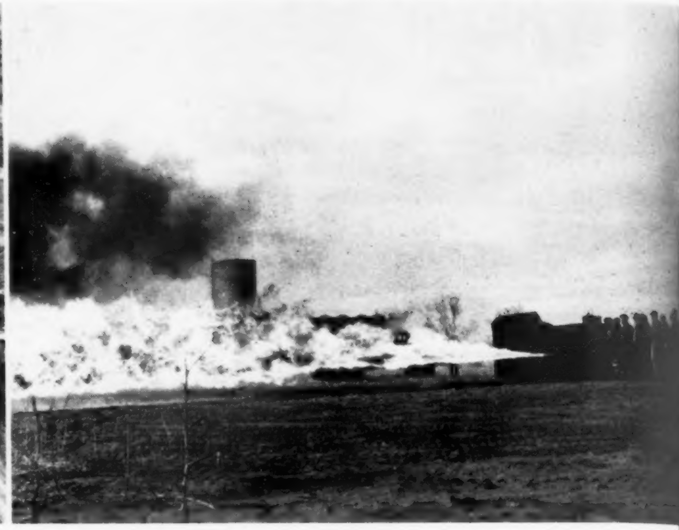
ROK troops, after only short training periods, have shown an adeptness in using the "fire guns" and "really love to use 'em," according to a Chemical Corps officer who just returned from Korea.

Last, but not least, we might mention one press comment about DDT. Discovered by a Swiss scientist more than half a century ago, DDT can hardly be called a Chemical Corps weapon. However, during World War II, the Corps' scientists developed a cheaper and more efficient means of producing the disease-killing powder. Now, in Korea, DDT is helping to win friends for the Americans. Colonel Glenn W. Dickerson, commandant of the POW camp at Pusan, told newsmen late in October that the use of DDT "to rid captured enemy of itching has done as much as anything to change the hostile attitude of thousands of prisoners."

As this is being written, our forces have suffered serious reverses on that rugged peninsula jutting down

*(Continued on Page 34)*

Aerial view of Rocky Mountain Arsenal looking west along December 7th Avenue to the Rocky Mountains.



Members of the 29th Ammunition Supply Squadron (Toxic Gas Section) Pueblo Ordnance Depot, Colorado, U.S.A.F., who are on 60 days temporary duty training at the Arsenal, are shown observing tests being conducted by the Field Equipment Branch in repair and renovating of the mechanized flamethrower.

# HISTORY OF THE Rocky Mountain Arsenal

By Clarence B. Wiley, Captain, Cml. C.*

In 1942, the need for production of warfare gases and chemical-filled munitions and an immediate urgent demand for incendiary munitions for use in the Pacific Theater of Operations was the primary cause for construction of a new chemical arsenal.

The plant site board of the War Production Board, Washington, D. C., in a memorandum dated 2 May, 1942, addressed to the Chief, Chemical Warfare Service, approved the construction of this new chemical arsenal to be located near Denver, Colorado. On 6 May 1942, Major General William N. Porter, Chief, Chemical Warfare Service, by memorandum to the Secretary of War, recommended that approval for this construction be given. This approval was authorized under memorandum of Approval No. 348, dated 12 May, 1942, by direction of the Secretary of War, under signature of Robert P. Patterson, Under-Secretary of War. Finally, after negotiations, verbal authorization to proceed with construction was received in June, 1942 by the Corps of Engineers and the Area Engineer, Huntsville Arsenal, Huntsville, Alabama, and they were directed to proceed to the site near Denver, arriving on 8 June, 1942. The total estimated cost was $62,415,000.

Thus, was born Rocky Mountain Arsenal, a Class II Chemical Corps installation. The site was chosen for the following reasons:

(1) Relative inaccessibility of attack from enemy planes due to its interior location and surrounding Rocky Mountain terrain; (2) Access to high-class labor market in the Denver area; (3) Local existing housing facilities; (4) Cheap and adequate supply of relatively low temperature process water and suitable supply of potable water; (5) Proximity to national, state, and county highways; (6) Proximity to the main line of the Chicago, Burlington, and Quincy Railroad and the right of way of the Union Pacific Railroad; (7) Favorable climate; (8) Suitable topographic, geologic, and soil conditions; (9) Adequate electrical power from both the Public Service Company of Colorado and the Rural Electric Administration; (10) Convenient telephone service by the Mountain States Telephone and Telegraph Company.

The arsenal is located in Adams County, Colorado, 12 miles northeast of the business center of Denver. The land, approximately 20,000 acres, was acquired from 474 individual owners by condemnation proceedings. A portion of the southern boundary of the Arsenal is adjacent to the city of Denver. The entire Rocky Mountain arsenal construction project was authorized by the Corps of Engineers. The prime construction contractors were Kershaw, Swinerton, and Walberg of San Francisco, California, and Birmingham, Alabama, and the H. K. Ferguson Company of Cleveland, Ohio (chlorine plant and thionyl chloride plant). The design consultants were E. I. du Pont de Nemours and Company of Wilmington, Delaware, and the H. K. Ferguson Company. The architect-engineer contractors were Whitman, Requardt, and Smith of Baltimore, Md., and H. A. Kuljian Company of Philadelphia, Pennsylvania; the H. K. Ferguson Company of Cleveland, Ohio; Kershaw, Heyer, Swinerton, and Walberg, San Francisco, California, and Denver, Colorado, (M69X incendiary bomb plant only).

Construction of Rocky Mountain Arsenal, which is one of the largest chemical corps arsenals in the nation, was rushed to completion in approximately 6 months' time in

*Capt. Wiley is the Public Information Officer at Rocky Mountain Arsenal, Denver, Colorado.

The Commanding Officer of the Rocky Mountain Arsenal with his special staff, left to right: Major John H. Clark, Chief, Manufacturing Division; Major Charles Greenberg, Post Inspector; Lt. Col. Bruce A. Crayne, Chief, Facilities Division; Lt. Col. David Armitage, Executive Officer; Colonel C. M. Kellogg, Commanding Officer; Lt. Col. Joe Fishback, Assistant for Administration and Services; Major William T. Bridges, Chief, Rocky Mountain Storage Area; Major Walter M. Smith, Storage Officer; Captain Ralph L. Aldrich, Provost Marshal; 1st Lt. Paul W. Walters, Assistant Adjutant; 1st Lt. Romeo DeLisle, Special Services Officer; 1st Lt. Arthur C. Smith, Chief, Communications Branch; Major Russell M. Tegnell, Comptroller; Captain George V. Muschany, Commanding Officer, 216th Chemical Service Co.; and Captain Clarence B. Wiley, Public Information Officer.

COLONEL CRAWFORD M. KELLOGG, Cml C
Commanding Officer

1942, with a final completion date of 15 November, 1943. The arsenal was first commanded by Brigadier General Charles E. Loucks, (who is scheduled to assume command of the Army Chemical Center, Md., in January). He was succeeded in command by Brigadier General Alexander Wilson, retired; Brigadier General Charles S. Shadle, retired; and Colonel Adrian St. John, retired. The present commanding officer is Colonel C. M. Kellogg, a native of Colorado.

In addition to the manufacturing plants, the arsenal includes an administrative building, maintenance shops, enlisted men's barracks, officers' quarters, mess hall, service club, officers' club, individual and converted warehouses with a suitable fire department, cafeterias, and station dispensaries. A few of the plants and facilities have been leased to industrial companies, such as the Colorado Fuel and Iron Corporation, Julius Hyman and Company, the Mountain States Bean Company, and, at various other times, small lessees.

The following is the scope of activities which went into operation at the completion of construction; chlorine plant; sulfur-monochloride and sulfur-dichloride; "H" manufacturing plant; "H" distillation plant; thionyl chloride plant; chlorinated paraffin manufacturing plant; M74 bomb filling and clustering plant; WP igniter tube filling plant; M47 incendiary oil bomb filling plant; M69X incendiary bomb filling and clustering plant; a fifth-echelon repair plant which covered 6 warehouses, including a change house, offices, repair shops and work and storage; the "L" manufacturing plant; and the bomb assembly branch which was set up for reconditioning and reclustering M69 bombs which were shipped into the arsenal from outside sources.

In addition to the manufacturing facilities, were the electrical system which included two 20,000 KVA three-phase transformers; complete processing and potable water system; industrial waste and sanitary sewage disposal system; steam and compressed air system; all roads; railroad spurs; special toxic gas areas, etc.; necessary to the complete functioning of a production arsenal. Included also were the magazines, igloos, and Rocky Mountain storage areas.

For excellence in design and construction, all of the prime contractors and the design consultants were awarded the Army and Navy "E." The Rocky Mountain Arsenal was thrice awarded the Army and Navy 'E" for excellence in production on the following dates: 3 June, 1944, 9 December, 1944, and 30 June, 1945.

### Demobilization and Reorganization Period

During the period of August 1945 to August 1950, the arsenal was in a general demobilization and reorganization. The operating plants were placed in a stand-by condition. The activities of the fifth echelon repair shop were discontinued in October 1945 and then reactivated on 12 February, 1946. Buildings originally constructed for the M69X unit were converted to house this activity. Negotiations were begun at this time to lease most of the plants facilities to private industry.

The German prisoner of war camp, comprising some two hundred sixty prisoners, was also discontinued and the original 9713-3 T.S.U. M.P. Detachment was redesignated as the 9713-3 T.S.U. Headquarters Detachment under the jurisdiction of the Chief, Chemical Corps. The number of civilian personnel went from a top figure of 3,100 during August 1945 to approximately 1,300 on 31 December, 1945 and approximately 600 in September, 1950. At this time, the arsenal was given a peacetime mission of repairing such items as 4.2 inch chemical mortars, flame-throwers, service kits, smoke generators, special chemical handling vehicles, and ammunition carts. A unit was also established to provide for the storage of chemical warfare materials known as deseret activities. Approximately 7 square miles of space was used for this activity. The maintenance branch of arsenal operations was used to maintain all plants in stand-by condition; the welding shop and the machine shop played an important part in this operation by being able to fabricate various scarce articles not readily found on the open market.

The strength of the Chemical Corps enlisted men reached an all-time low in December 1946 when the total authorized and actual strength was one (1) enlisted man. In May, 1946, the 1736th Service Command Unit stationed in Denver was transferred to Rocky Mountain Arsenal and consisted of five (5) officers and one hundred fifty (150)

Mr. Glen Pollard shown at work in the control laboratory, Julius Hyman and Company.

Tools, Dies and Fixtures, Bldg. 732: Renovating Program for Reserve Industrial Equipment. Schedule nearing completion. Building will be converted to M19 Incendiary Cluster Renovating Line. Insert: Mr. Al Hervey, shop foreman.

enlisted men. At that time, it was redesignated as the M.P. Detachment, 5605th Area Service Unit. The strength of this unit was reduced to approximately fifty (50) enlisted men and five (5) officers in August of 1950 and then to a number of five (5) officers and no enlisted men in September, 1950.

During the period of 1 January, 1947 through December 1949, the following were the activities carried on at the arsenal:

A. Processing industrial reserve components and equipment for extended storage.

B. Reconditioning ton containers.

C. Reconditioning AN-M76 bombs.

D. Rehabilitating decontaminating apparatus.

E. Placing plants in stand-by condition.

F. Co-ordinating negotiations for leasing of various plants to commercial interests and completing inventory of property to be included in current leases.

G. Preparing postwar plans.

H. Planning for new program of demilitarization of ordnance shells.

I. Training general reserve unit—92nd Chemical Service Company and subsequent shipment overseas.

### Present Arsenal Activities

At the present time, there are but few troop activities at the arsenal. The Hq. Detachment 9713-3 T.S.U. consists of 1 captain, 1 first lieutenant, and approximately 50 enlisted men. Also presently assigned is the 216th Chemical Service Company, a general reserve unit. This unit consists of 1 captain and 25 enlisted men, which forms the cadre for the entire unit. The cadre was taken mainly from the 92nd Chemical Service Company which was activated and received its training at the arsenal. At the present time, the 92nd Chemical Service Company is serving overseas in Korea.

Much practical experience is offered this type unit as they receive the maximum amount of on-the-job training in the various arsenal activities which trains them in their assigned specialty. Also, the mountainous terrain of the nearby Rocky Mountains is an excellent place for them to receive their tactical exercises, bivouacs, and maneuvers. Combat courses are covered by trips to nearby Camp Carson, Colorado, where facilities, such as ranges, infiltration courses, and overhead artillery fire, are made available. The pistol range on the arsenal was recently converted to a 1,000 inch instruction range for the carbine. An obstacle course is also under construction.

During World War II, the Western Chemical Warfare School was moved from Camp Beale, California, to the Rocky Mountain Arsenal on 10 June, 1944. The faculty, staff, and school detachment consisted of approximately 14 officers and 36 enlisted personnel. The maximum number of personnel attending the various courses of instruction reached 400. Courses offered were: Navy gas course—enlisted and officer, noncommissioned officers' gas course and unit gas officers' course. Shortly after the end of World War II, the Western Chemical Warfare School was discontinued and most of the officers and enlisted men were transferred to the Chemical Warfare School at the Army Chemical Center, Maryland, or absorbed by the Rocky Mountain Arsenal Headquarters Detachment.

At various times, the Rocky Mountain Arsenal has trained ORC units, and Air Force units, and conducted regular tours for officers and airmen from nearby Lowry Air Force Base through the Arsenal activities. During the summer of 1950, 1,200 Air Force ROTC cadets from Lowry Air Force Base received courses in radiological defense and gas defense at the Arsenal. The Radiological Defense Instructor was Col. Thad P. Sears, Chief of Medicine at Ft. Logan Veterans Administration Hospital, and a graduate of various atomic and radiological courses at Oak Ridge, Tennessee, and Oakland, California.

It is anticipated that more ORC Chemical Corps units will be trained at Rocky Mountain Arsenal during the summer of 1951.

One officer and 12 airmen from the Toxic Gas Section of the 29th Ammunition Supply Squadron, Pueblo Ordnance Depot, Pueblo, Colorado, arrived on 15 November, 1950 to undergo 60 days' training in handling chemical munitions and operation of a toxic gas yard. Much practical experience is being gained by them.

During the period of 1 January, 1950 through 31 December, 1950, the following activities have been carried out at Rocky Mountain Arsenal:

An increase in officer and enlisted personnel was authorized to meet proposed schedules.

The Engineering Unit was busy investigating and recommending methods of heating cleaning tanks for the manufacturing division's tool, die, and fixture project, proposed fire alarm system, proposed ton container plant, exhaust duct for the H demilitarization plant and many others.

The manufacturing division completed the establishment of a reconditioning plant for approximately 10,000 ton containers; operation of the clothing treatment plant to back up the Shell Demilitarization Project; the tools, dies, and fixtures program which consists of inspecting and verification processing and storing of industrial reserve equipment; the field equipment processing which was charged with the following programs of repair and reassembling for final inspection, plant impregnating, swinging booms, trucks, cranes; portable and mechanized flamethrowers, set equipment maintenance and repair, air compressors, and mechanical smoke generators.

The following extract from the Denver Chamber of Commerce's publication, "Denver," on 30 November, 1950, helps sum up the part that the Rocky Mountain Arsenal has played in the local and national picture during the last war and will play in any future emergency as follows: "The Rocky Mountain Arsenal in Denver is in the process of a large scale expansion in connection with the present war emergency. Projects at the Arsenal will vitally affect the defense of the United States, should a greater emergency arise. The Arsenal has always been a big economic asset for Denver. Securing the Rocky Mountain Arsenal for our city was one of the most dramatic achievements of community teamwork in Denver."

Today the Arsenal with all its facilities and personnel stands ready, willing, and able to play any role or to carry out any assigned project it may be called on to fulfill.

### The Commanding Officer

Colonel Crawford M. Kellogg, the present commanding officer, arrived in February, 1949, to take command of the Rocky Mountain Arsenal.

The commanding officer was commissioned as a 2nd Lieutenant, Cavalry, in 1917, and served in World War I as a 1st Lieutenant and Captain in the 80th Field Artillery, Seventh Division. After World War I, Colonel Kellogg served with the Chemical warfare service as corps area chemical officer, 5th Corps Area; as a company commander in the First Gas Regiment and Second Separate Chemical Battalion; and as Assistant Professor of Military Science and Tactics, Massachusetts Institute of Technology. He commanded the Fourth Separate Chemical Company and was chemical officer of harbor defenses of Manila and Subic Bays and of the Philippine Division in the Philippine Islands. After his return from the Philippine Islands in 1934, he attended the Air Corps Tactical School and was then assigned as Chief, Munitions Division, Edgewood Arsenal, Maryland. He also served as chief of the Engineering Section, Technical Division, and Chief, Training Section, Office of the Chief, Chemical Warfare Service, Washington, D. C.

Colonel Kellogg served thirty-three months overseas during World War II, and was awarded the Bronze Star medal and the Army Commendation Ribbon with one Oak Leaf Cluster. He served as chemical officer of the Eighth and Second Air Forces, as air chemical officer of the China, Burma, India Theater from 1944 to 1945, and as chemical officer of the Eighth (1945) and Sixth (1946-1948) Armies.

He is a graduate of the Chemical Warfare School, 1922; The Chemical Warfare School Field Officers' Course in 1935; the Air Corps Tactical School in 1936; Command and General Staff School in 1941; and has constructive credit for the Army Industrial College.

Colonel Kellogg is a native of Colorado and attended Leland Stanford Junior University, graduating in 1916 with an A.B. degree.

## INDUSTRIAL LESSEES

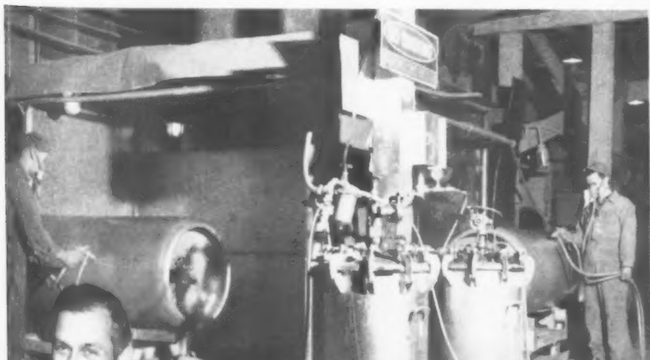
### Julius Hyman & Company, Chemical Manufacturers

Julius Hyman & Company is engaged in the manufacture of chemicals and in an active program of chemical research at the Rocky Mountain Arsenal near Denver, Colorado, on property leased from the United States Government through the Department of the Army. The company's manufacturing facilities, executive offices, and laboratories are housed on this property. It has been established there since February 1, 1947, and, recently, has expanded its operations through the leasing of the electrolytic chlorine plant, which had not been in operation since September 1948. The Hyman Company also operates the utilities at the Rocky Mountain Arsenal which produce and distribute electricity, steam, and industrial and potable water.

From the beginning of its operations at the Rocky Mountain Arsenal, Julius Hyman & Company has concentrated upon the production of insecticidal chemicals. In the spring of last year, they commenced manufacture of the insecticide "aldrin" on a large commercial scale. Some time earlier, pilot plant production of "dieldrin," also an insecticide, got under way. Both of these compounds were discovered and developed in the Hyman research laboratories at the Rocky Mountain Arsenal. "Aldrin" has

*(Continued on Page 39)*

Employee on the right is applying lead coating to the ton container and man on left is applying silver coating. Insert: Mr. Rodney Pinkney, foreman, Ton Container Renovating Project, Manufacturing Division.



Combined Crafts, Bldg. 543: Maintenance support shops—part of the manufacturing division, interior view is shown. Inset: John J. Corazza, senior shop foreman.

# THE NATIONAL SCIENTIFIC REGISTER

JAMES C. O'BRIEN

By James C. O'Brien

Director, National Scientific Register

Work is well under way in a high priority project to register American scientists and technologists. Approximately 150,000 scientists will be asked to participate in what is expected to be one of the most comprehensive registrations of scientific personnel yet attempted by the Government. This operation is being undertaken by the National Scientific Register, sponsored by the National Security Resources Board, and administered by the Office of Education, Federal Security Agency. The registration will include qualified scientists in the natural and physical sciences, and will be accomplished through the direct assistance of the principal professional and scientific societies. The purpose of the registration is to provide urgently needed information on the country's supply of technological personnel in the many scientific fields —information needed for both immediate and long-range mobilization planning. Surprising though it may seem, it is probable that the Department of Agriculture has more information concerning the livestock of the country than any agency has concerning the precise characteristics of the critically important scientific population.

The need for an analytical index of American scientists became apparent to the NSRB when lack of specific information began seriously to hamper efforts to prepare complete and comprehensive mobilization plans. Provision has been made for such a register in legislation creating the National Science Foundation. However, because of the international situation early in 1950, the NSRB decided that this important function could not be delayed longer, and that some interim action should be taken pending the creating of the NSF. Accordingly, the National Scientific Register was established in the Office of Education in the summer of 1950. James C. O'Brien of the Office of Manpower, National Security Resources Board, who formerly headed the wartime National Roster of Scientific and Specialized Personnel, was named Director of the new enterprise.

The National Scientific Register was given the responsibility for providing answers to two pressing questions in the over-all manpower problem: (1) What are the characteristics of the supply of scientific and technological manpower in the country? and (2) What will be the requirements for scientists and technologists in all phases of mobilization?

It appeared that the only practical method of obtaining answers to the first of these questions was to effect a registration of scientists by means of questionnaires designed to obtain the specific types of information required. The whole project is a voluntary one with the scientists themselves cooperating with the Government to make the enterprise a success. Committees of leading scientists in each of the fields to be covered were consulted and an effort was made to develop specialty check lists which would serve as the basis for all of the various types of studies required.

The scientific fields to be included in the present registration are as follows: physics, chemistry, the biological sciences, geology, geophysics, meteorology, astronomy, mathematics, and crystallography. Registration will not be made in the engineering fields at this time since the recent study of American engineers, sponsored by the Office of Naval Research and completed under the direction of the Engineers Joint Council, has been made a part of the National Scientific Register. When registrations in the fields of science just named have been completed, it is anticipated that a follow-up study will be made in the fields of engineering to complete the coverage.

The problem of ascertaining and projecting requirements for scientific personnel is more difficult and research studies are being set up to determine the best means of obtaining required data and coordinating efforts of the various governmental agencies in attacking the over-all problem.

Information obtained through circularization of scientists will be analyzed and interpreted by a special coding group, and the results will be recorded in an electronic punch card system. A survey was made of the various newly developed techniques for the mechanical recording, tabulating, and interpreting of such data, and the Register has adopted several new devices which should result in the most advanced system of personnel registration developed.

The major scientific and personnel societies and councils of the country are cooperating to the fullest extent with the Government in preparing the Register. In the field of chemistry, for example, the American Chemical Society has accepted responsibility for the circularization of chemists, both members and non-members of the Society. It is anticipated that between seventy and ninety thousand chemists will be sent questionnaires. The importance of complete registration of chemists is obvious since statistical studies pertaining to total supply and demand factors will be affected. As the national emergency increases in intensity, it becomes more and more apparent that full utilization of skills in the field of chemistry, considering implications in the munitions and armament programs, is of vital importance in our national defense.

The National Scientific Register project has been given a high priority by the NSRB in view of the critical role played by American science in the last war, and in recognition of the fact that American security and supremacy in a future war will depend to an important degree on the total utilization of scientific and technological skills. Important statistical studies need to be undertaken at an early date, and the comprehensiveness of data included in these studies will be an important factor in the total mobilization planning effort of the Government. While the National Scientific Register at present does not envision a large-scale placement function, data

*(Continued on Page 34)*

# AMERICAN CYANAMID

# ties into National Defense . . . .

By Charles C. Dayton
American Cyanamid Company

The Army Quartermaster Corps recently announced a standardization and conversion program in all mess halls—from china to melamine-formaldehyde plastic dinnerware. For almost three years the Army has been testing plastic dinnerware. They've dropped it from varying heights—boiled it—determined general soldier reaction and preferences—calculated annual replacement cost—subjected it to varying climatic conditions—determined the degree of durability. A member of the Quartermaster General's Office recently declared, "The overwhelming advantages of melamine plastic tableware make it a 'natural' for Army-wide use." The melamine-formaldehyde molding compounds for these thousands of dishes will be supplied by American Cyanamid Company.

This development highlights an important factor concerning the chemical industry. In many ways, it is unique. An automobile manufacturer must make drastic changes before he can produce tanks; metal products producers must set up whole new assembly lines, backed by endless hours of engineering, before they can switch from the production of printing machinery to that of gun mounts. But in the chemical industry, many plants can continue to make acids and alkalis, industrial chemicals or synthetic resins, intermediates and dyes—and the only change from peacetime is that more of these products must be produced and the uses to which they are placed are different.

The Cyanamid organization's diversified products are typical of the outstanding contributions made to the defense effort by the chemical industry.

The end uses of melamine-formaldehyde resins, as exemplified by the durable dinnerware mentioned above, have been important contributions to America at peace or in a period of mobilization. But they are only one of hundreds of ways in which this chemical company serves the armed forces. Laminac Resin, another Cynamid plastic, has been used extensively for radomes and antenna housings, wing tips and Doron bullet-proof vests. A new use for this compound is an entirely redesigned automatic film magazine for aerial cameras. The Company's Agricultural Chemicals Division supplies nitrogen fertilizers to aid the farmer in obtaining higher yields. Its insecticides, plant hormones and weed killers help protect crops. The Lederle Laboratories Division produces countless drugs for human use, as well as important veterinary products. The Petroleum Chemicals Department makes cracking catalysts used in the refining of high octane gasoline. In fact, practically all of American Cyanamid's products are used in some way to aid the defense effort.

Calco, largest of the Company's Divisions, is one of the country's foremost manufacturers of dyes, pigments and intermediates. Its dyes are responsible for the greenish-yellow dye markers used by pilots downed over the ocean. A small quantity of the dye will cover a large area. Its color can be seen for many miles by searching planes. During the war, sea rescues were almost commonplace and it has been stated officially that thousands of men alive today owe their existance to these chemical dyes.

It is a dye, too, that keeps sharks away from downed airmen. A combination of a special black dye, developed by Calco, and an odorus chemical salt is used for this purpose.

The Division's dyes are also used for a large range of colored smokes; for uniforms and other service materials; for leather used in boots and holsters. Calco pigments are used in the paints applied to all types of military and naval equipment. Calco produces a complete line of sulfa drugs.

An important percentage of Cyanamid's production is devoted to life saving pharmaceuticals, biologicals and similar products used by the medical profession. The Lederle Laboratories Division plays a leading role as one of the country's largest producers of pharmaceutical, biological and veterinary items. Aureomycin, discovered by Cyanamid, is successful in combating a long list of diseases. It has also been found useful in supplementing animal diets. Sulfadiazine and other sulfa drugs introduced by Cyanamid have seen extensive military duty.

During World War II, Lederle operated the largest blood plasma processing plant in the world. The first shipment of plasma left the plant two days before Pearl Harbor. A considerable amount of other wartime needs were filled by Lederle—a third of the typhus vaccine used . . . fifty percent of the gas gangrene antitoxin . . . thirty three percent of the influenza vaccine . . . half of the tetanus toxoid . . . ninety percent of the pneumonia sera . . . all of the blood grouping sera . . . forty percent of the Japanese B. encephalo vaccine. The Laboratories also cooperated on research programs with the Surgeon General's Office.

Davis and Geck, Inc., another Cyanamid subsidiary, manufactures quality surgical sutures and needles. They supplied vast quantities of these items during the last war. During the recent flood in Winnepeg, Canada, Davis and Geck donated emergency suture packs to the Canadian Red Cross. Its success in this case indicates the importance of this new package to the operations of the armed forces. Davis and Geck also maintains a comprehensive library of films and operational procedures. Shown to doctors, nurses and surgeons all over the world, these films have proven an invaluable aid in the dissemination of information and technics on all types of operations.

Returning to melamine, shortly after Pearl Harbor, military maps, printed on melamine resin treated paper to give them wet strength, were given to the Army for testing. They were put on the floor near barracks, where

hundreds of muddy boots trampled over them each day. They were washed and wrung dry. Paint and grease were smeared on them. They were cleaned with paint remover. They were washed in gasoline. At the end of the tests, they were still intact and legible.

Further research showed that the compound had a combination of properties unknown to any other plastic. It possesses dimensional stability and heat resistance, has dielectric strength and high arc resistance. These are the very characteristics necessary in airplane ignition systems to assure continued functioning in rarefied air, desert heat and artic cold.

Melamine took to the air. As a result, the ceiling of our propeller driven planes has been raised. They have been given a wider margin of safety and maneuverability. The performances of the Thunderbolt, Hellcat, Liberator, Mustang and Superforts are impressive testimonials to the plastic's value.

Melamine went to sea. The Navy found its properties useful for heavy circuit breakers, which must be capable of withstanding the shock of big guns and have exceptional fire and arc resistance. Control panels composed of melamine resin and glass fibre provide insulation and fire resistance for the big ships' power plants.

Buttons made of melamine have been found superior to others. Wool liners for sleeping bags seldom shrink when treated with it. Fullness, texture and wearing qualities of leather are improved when melamine is used in its manufacture. It's used in heat resistant searchlight reflectors. Melamine finishes perform equally well on helmet liners and on tank interiors. Melamine helps make clothing water repellent.

Another member of the Cyanamid family, Chemical Construction Corporation, began building chemical plants for national defense in World War I. They built the acid facilities for the nitrate plants at Muscle Shoals and Sheffield. During the Second World War, Chemical Construction contributed materially to the chemical plants program of the allied nations. In 1937, it began the design and supply of a number of sulfuric and nitric acid plants for Great Britain. Its work abroad also included acid and ammonia plants in India, Australia and Canada.

In the United States, it supplied major acid and ammonia units at numerous ordnance works. It engineered four new types of projects under Defense Plant Corporation auspices. It developed a new process for recovering spent alkylation acid and installed three large plants employing this process. The firm was architect—engineer—constructor for the Chemical Warfare Service 4X Manufacturing Plant at Azusa, California. It built numerous plants vital to the defense effort for private customers.

Recently, Cyanamid has begun contract negotiations with the Atomic Energy Commission for the operation of a chemical processing plant. The plant, at the Reactor Testing Station in southeastern Idaho, will recover nuclear fuel from used reactor fuel elements.

American Cyanamid is the world-wide technical and sales representative for the Heavy-Media Separation Processes. The processes are used to up-grade low grade ores which will not respond to other benefication methods. During 1949, slightly more than 2,000,000 tons of iron ore, up-graded by HMS, were shipped from the Great Lakes region alone. Without HMS, this ore could not have been used. Other vital ores, such as lead, zinc, chromite and lead-zinc are concentrated by these processes. HMS is also employed to concentrate metallurgical coal used for making steel.

An important use for resin adhesives was their combination with starch pastes to provide a highly water-resistant bond. Millions of weatherproof shipping containers are used by the Army and Navy to transport supplies to all parts of the world.

When World War II entered the Philippines and the Pacific region, the country was cut off from its major source of rubber. The chemical industry was called upon to create a billion dollar synthetic rubber industry from almost nothing in two years. Fortunately, acrylonitrile, developed by Cyanamid, had gone into production in the late 1930's. The Company was one of the few manufacturers able to supply this important component of the Buna type synthetic rubbers.

Although Cyanamid may not manufacture items used directly by the armed forces, it makes countless products used by almost every industry, enabling those industries to operate more efficiently and produce better products.

The Company was founded in 1907 for the manufacture of one basic product—nitrogen fertilizer. Its first plant, at Niagara Falls, Ontario, employed the nitrogen-fixation process. Nitrogen, taken from the air, was combined with calcium carbide. The end product was calcium cyanamide.

Through the years, more plants were built to produce other items. Plants were expanded. New units were acquired. Today, the Cyanamid family embraces forty-two plants stretching from coast to coast, from Texas to Canada. Approximately 20,000 people are employed. Sales and branch offices encircle the globe.

What was once a "one product" manufacturer has now become one producing roughly 5,000 items for use by over 200 industries. The eight major divisions of the Company turn out chemicals used in the production of rubber, textiles, paper, metals and the tanning of leather. The Company is among the foremost manufacturers of plastics and resins, weed killers and insecticides. It makes explosives and mining chemicals. It provides the petroleum industry with catalysts to improve gasoline and additives to improve motor oils. Lederle turns out hundreds of pharmaceutical, biological and veterinary items. Chemical Construction, besides building acid and fertilizer plants all over the world, develops new chemical manufacturing processes.

One of the predominant factors behind Cyanamid is research. More than 10 million dollars is spent annually by the Company on research activity alone. Proportionately, it is one of the highest outlays in the chemical industry.

The central research laboratories at Stamford, Connecticut, employ almost 900 men and women—over half of them having technical degrees. They work solely and constantly on basic research ... development of new products ... new applications for old products. Other important research centers are maintained at Lederle's Pearl River, New York plant and Calco's Bound Brook, New Jersey plant. Application and control laboratories at many of the other plants bring the total of technically-trained personnel for research to over 1,500.

The Laboratories at Stamford were established in 1936 because the officers of the Company, knowing that the future of any chemical concern depends on scientific research, believed in the ability of men and women to build for that future. In the midst of a depression, these Laboratories were a calculated risk; they have since become an integral and essential part of a large chemical concern. Recognized as one of the world's largest and most highly diversified industrial research centers, they have almost doubled in size since 1936, now occupying more than 410,000 square feet. The several buildings with their myriad of laboratories and rooms are a far cry from the first laboratory built by the Company in the early 1900's. It was in a corrugated shack heated by a pot bellied stove.

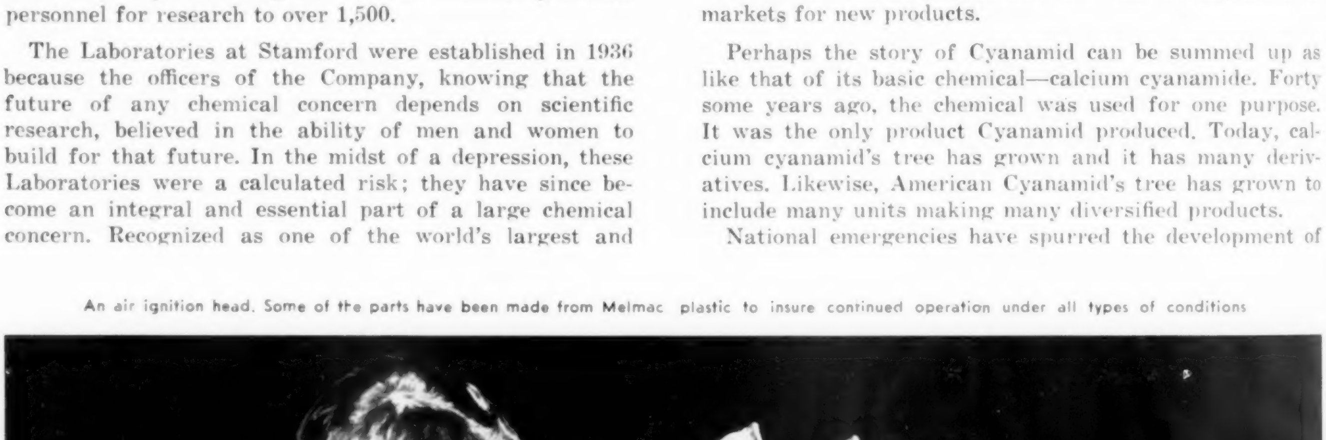
Cyanamid research has proved its worth. The Stamford, Lederle, and Calco Laboratories working collectively or individually have fostered such outstanding products as the "wonder drug," Aureomycin; Parathion, one of the newest and deadliest insecticides on the market; Artane, used for the cure of palsy; folic acid, an important component for human and animal nutrition; micro-spheroidal cracking catalysts used to convert semi-refined petroleum into high octane gasoline and similar products. From the original basic product—calcium cyanamide—it has evolved melamine and its countless applications, acrylonitrile, and some of the components of the sulfa drugs. Cyanamid has taken the lead in developing chemical finishes for fabrics. These chemicals make cloth shrink and wrinkle resistant, fire retardent and water repellent.

A unique and practical group working in conjunction with the research staffs is the New Product Development Department. Organized for the purpose of introducing to industry new chemicals which come out of the research laboratories, its activities include both the expansion of markets for existing products and the development of markets for new products.

Perhaps the story of Cyanamid can be summed up as like that of its basic chemical—calcium cyanamide. Forty some years ago, the chemical was used for one purpose. It was the only product Cyanamid produced. Today, calcium cyanamid's tree has grown and it has many derivatives. Likewise, American Cyanamid's tree has grown to include many units making many diversified products.

National emergencies have spurred the development of

An air ignition head. Some of the parts have been made from Melmac plastic to insure continued operation under all types of conditions



many chemicals. Fortunately, unlike the machines of war, these chemicals are just as useful in peacetime. Melamine has found its way into many home applications. Acrylonitrile is now the basic chemical for new synthetic fibers. Blood plasma is used every day. Pharmaceuticals are as effective for a small boy as they are for a soldier.

When the chemical industry is called upon to produce for defense or for war, products which give sheer evening gowns durability make tents impervious to attack by tropical climate; plastics which are used to produce seamless one-piece pleasure boats are used for small combat vessels which are light and strong and need practically no maintenance or repairs; drugs immunize soldiers against tropical diseases and greatly cut the mortality rates of the sick and wounded; agricultural chemicals make greater crops possible and allow us to feed adequately our Armed Forces, as well as our civilians. During the last war, the chemical industry found substitutes for the quinine used to fight malaria. It produced synthetic rubber supplies sufficient to replace all the natural rubber once imported from foreign countries. It made tremendous quantities of explosives, played a leading role in the development of the atom bomb, and in countless quiet ways helped Americans win the war. Plastic cocoons which preserve vital parts of merchant ships, combat vessels, tanks, planes and guns were made possible by vinyl resins, a product of the chemical industry.

Any job of mobilization will place a heavy responsibility on the chemical industry, because of all the vital war industries, there is none more basic or vital than chemicals. Without its products to play their roles, there would be no tanks, no planes, no ships, no guns.

The chemical industry is in a better position today to fulfill its responsibilities than it has been in all its long history. Because it has carried on an aggressive research and development program, it can turn its vast productive capacity to whatever ends are most required—whether they be for peace, for defense, or for war.

The light-weight plastic serving unit easily handles the problem of feeding three decks of soldiers at once.

—Army Chemical Center Photo.

Among the many subjects taught by the Chemical Corps School are recognition and detection of gases. Here a student uses a portable detector kit to test ground which may have been contaminated.

# 30th BIRTHDAY FOR THE CHEMICAL CORPS SCHOOL

**SCHOOL TO BE SHIFTED TO ALABAMA**

*Since this article was written it has been announced that the Chemical Corps School and Replacement Training Center will be moved to Fort McClennan, Alabama. The move will begin this spring.*

**Next month, the Chemical Corps School at Army Chemical Center, Maryland, will observe the 30th anniversary of the start of its first class in January, 1921.**

It will pass that milestone with the knowledge that now, perhaps more than ever before, it is a vital force in training military and civilian alike in the use of and defense against the specialized weapons which could play a key part in a third world war.

Events which produced a need for the Chemical Corps School make up the history of the Chemical Corps itself.

It was on April 22, 1915, that German soldiers released a cloud of chlorine gas that was borne by the wind across French and British lines near Ypres, Belgium.

The French retaliated with phosgene. The Germans came back with mustard.

Thus began gas warfare—a method of fighting which, despite its early clumsiness, achieved widespread effectiveness during World War I and untimately accounted for 30 per cent of all American casualties in that conflict.

The United States did not enter the war until two years after the first use of gas. Yet it plunged into battle totally unprepared—either offensively or defensively—for gas warfare. The Medical Corps, the Engineers, Ordnance, the U. S. Bureau of Mines—all were given a share in the job of shaping early chemical

warfare tools and defenses. But their efforts were not correlated; as one officer put it, "Gas was a bad dream and nobody's responsibility."

Then the Americans decided to make it someone's responsibility. In 1918 the 30th Regiment, Corps of Engineers, was designated the "Gas and Flame Troops" in France. Out of that grew the old 1st Gas Regiment, which on July 1, 1918, became the Chemical Warfare Service. The CWS in turn was redesignated the Chemical Corps in 1946.

During the early period of CWS development, numerous temporary "schools" to train military personnel in chemical warfare were set up in the United States and abroad. A regular CWS school was established at the Lakehurst Proving Ground in New Jersey in January, 1920.

But it was not until the Chemical Warfare School was opened at Edgewood Arsenal, Maryland, on September 20, 1920—less than two months after the Chemical Warfare Service became a regular branch of the Army—that effective, coordinated training in all phases of chemical warfare was made available both to military personnel and to civilians employed by the armed forces.

Today the Chemical Corps School continues to provide that training under its new Commandant, Colonel Frederick W. Gerhard. A veteran of 32 years in the Army, Colonel Gerhard recently succeeded Colonel Geoffrey Marshall, who retired October 31 after 33 years' active service and more than two years as head of the School. Colonel Gerhard had been Deputy Commandant since August 3.

The School's beginnings were small: one 12-weeks' "line and staff" course which started in a tiny barracks in the old 1st Gas Regiment area on January 10, 1921, under direction of the late Major E. J. Atkisson, first of the School's 11 Commandants to date.

But though its beginnings were small, the School's growth was rapid. In 1922 it became in effect a joint service school to train members of the Navy and other armed services as well as the Army. In 1924, with Colonel Charles W. Exton having succeeded Major Atkisson as Commandant, it moved into its own buildings.

However, the School did not hit its full stride until start of the World War II emergency. Whereas it trained and graduated only 3,976 persons between January 1920, and September 6, 1940, the School graduated 30,550 students between September 7, 1940, and August 5, 1945. Of the latter total, 25,249 were Army personnel (active, reserve and National Guard officers, enlisted specialists and officer candidates), 4,174 were members of Navy components, 1,038 were civilians and 88 were foreign officers.

At the present time the Chemical Corps School, with a force of 84 officers and warrant officers, 240 enlisted personnel and 142 civilians, conducts courses of from two to 40 weeks' duration in all phases of Chemical Corps activities including radiological defense.

But schooling is only part of its vast job.

The School also maintains a large library, a printing plant, and an always-busy writing, illustration and extension-course branch.

Its writers prepare for the Department of the Army all field and technical manuals, extension courses and texts, and other publications which are the responsibility of the Chief Chemical Officer.

Its illustrators contribute the necessary "art work."

Its extension branch administers correspondence courses for all armed forces personnel in all subjects pertaining to chemical and allied warfare.

All work together in accomplishing the prime mission of the Chemical Corps School: "To teach through residence and extension instruction, organization, tactics, technique and technical specialties to officers, enlisted men and civilian employes of the Chemical Corps and other branches of the armed forces so that they may perform their duties intelligently and efficiently; to develop doctrine; to prepare and review D/A publications appropriate to the mission of the Chemical Corps; to serve as technical adviser to the Chief Chemical Officer and chiefs of major activities of the Corps on matters within the scope of the School's responsibility; and to disseminate information relative to the instruction and training conducted at the Chemical Corps School."

Colonel Frederick W. Gerhard, left, new Commandant of the Chemical Corps School, is greeted by retiring Commandant Colonel Geoffrey Marshall. Colonel Marshall retired from the Army on October 31, 1950, after 33 years of active service. Colonel Gerhard is a veteran of 32 years' service.

—Army Chemical Center Photo.

This large building at Army Chemical Center, Maryland, houses most of the administrative and classroom activities of the Chemical Corps School, although other School operations are spread over much of the north end of the sprawling Center.

—Army Chemical Center Photo.

Brig. Gen. E. F. Bullene joined with the membership committee of the Armed Forces Chemical Association at a luncheon November 15. Present, reading clockwise above, were Maj. Mary B. Warner, Lt. Col. George R. Oglesby, Mr. Irving Morgan, Col. Jacquard H. Rothschild, Mr. Ed Schwanke, Col. Henry M. Black, Mr. Lester J. Conkling, General Bullene, Mr. Fred Shaw, Col. Edwin Van Keuren, Mr. H. C. Knight, Lt. Col. Ronald L. Martin, Mr. O. B. Mahaffie, Lt. Col. Joseph Prentice and Lt. Col. Montesque T. Moore.

# AFCA PROMOTION PLANNED AT CHEMICAL CENTER MEETING

The Army Chemical Center's highly successful campaign to increase AFCA membership was highlighted by a luncheon meeting on November 15th. With General Bullene sparking the meeting, the accomplishments of the Association were praised, and the membership committee pledged itself to unremitting efforts to strengthen the Chemical Center Chapter of the AFCA.

It's only four years old, but the Armed Forces Chemical Association already has established itself firmly as a common meeting ground for the armed forces and the greatest chemical industry in the world.

As members of the Association, military and civilian personnel find an opportunity to exchange viewpoints and discuss theories. Because it offers this opportunity, the Association has grown steadily since its founding in 1946.

Fred B. Shaw, Jr., president of the Association's Army Chemical Center chapter, gave this prime reason for the organization's existence:

"The Armed Forces Chemical Association serves to encourage, assist and simplify the efforts of the Chemical Corps to fulfill the important role and the tremendous destiny that the course of history has thrust upon it."

Mr. Shaw said the Association "can and has helped the Chemical Corps in accomplishing its grave assignment by providing a medium of contact between industry and the Armed Forces, wherein divergent views can be aired and where misconceptions which one group has concerning the operations of the other can be cleared away."

"It provides a society and a publication (the ARMED FORCES CHEMICAL JOURNAL) which can keep each group informed of the developmental progress, the manufacturing improvements, the organizational changes and the new fields of interest of the other," he said.

"It provides a mechanism whereby the activities and the accomplishments of the Chemical Corps can better be brought to the attention of industry and to the population as a whole, thereby ensuring still greater appreciation of and cooperation with the Chemical Corps program."

General Bullene, offered his warm support of the AFCA in the following statement:

"At least on this side of the Iron Curtain the Chemical Corps is unique in military organization. No other nation has organized a Chemical Corps as such. The mission of the Chemical Corps, U. S. Army, in foreign armies is divided among other branches and ministries. However, we all feel that regardless of the precedent of foreign organization, our organization is proper for the United States.

"The organization for National Defense for any nation must reflect its industrial potential. The United States has the greatest chemical industry in the world, and the chemical industry in this country is the greatest industry, dollars and cents-wise, of all the industries of the greatest industrial nation in the world. Therefore, we have a Chemical Corps because we have a great chemical industry.

"The Armed Forces Chemical Association is an association whose mission is to bring the chemical industry and the Chemical Corps into close contact. It is, therefore, believed that a healthy membership in the Armed Forces Chemical Association is to the interest of the Chemical Corps and National Defense in general."

*paper sculpture by gorecka-egan*

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# THE USE OF THICKENED GASOLINE IN WARFARE

By E. W. Hollingsworth

Chief Engineer, Munitions Division, Technical Command, Army Chemical Center, Md.

Portable Flame Thrower in action, flame penet

### Introduction

Incendiary warfare became an important factor during the early days of the Greeks and Persians. Burning crude oil, pitch and asphalt were effective weapons for land and sea warfare during the period prior to the use of gunpowder. The percursor of the flame thrower also dates from the Greeks who used a hollow log from which was blown by bellows the flames of a fire burning at one end.

After the introduction of gunpowder, incendiary warfare decreased in importance and remained a minor factor in warfare up to the time of World War II. During this long period little real progress was made in the art of incendiary warfare with the exception of development of magnesium type incendiary bombs. At the beginning of World War II a flame thrower had been developed which projected flaming gasoline—fuel oil mixtures as much as 20 yards distance, but the weapon was dangerous to friend and foe alike. The burning oil and pitch of the early days had been replaced by an incendiary bomb of doubtful value filled with crude oil.

During the years just prior to World War II, little attention was given to petroleum warfare. As the war clouds gathered, however, interest revived and active work was initiated by the Chemical Corps during the summer of 1941. Incendiary warfare, including petroleum warfare, grew in importance as a result of combat experience and eventually became a major factor in the overall war effort and accounted for the major effort and contribution of the Chemical Corps. Of the incendiary agents used, thickened gasoline became, by far, the most important agent. The most important applications of the thickened gasoline were in the incendiary and fire bombs, and in the flame throwers. Each of the applications will be discussed later, but first it may be desirable to give some of the background on the subject of thickened gasoline.

### Early Work on Gasoline Thickeners

One of the major obstacles to using petroleum products as incendiary agents was the low viscosity of those petroleum products which possessed the vapor pressure required to insure ignition. When used in bombs the petroleum fuels were atomized excessively by the explosive force of the burster, resulting in a relatively ineffective instantaneous flash or fireball. Likewise, when used in flame throwers the range was short due to excessive burning of the fuel before it reached the target and also due to the inability of the liquid rod to withstand the impact with air when projected at high velocities. The optimum results under these conditions were usually obtained by mixing as high a proportion of heavy oil with gasoline as practicable consistent with good ignition.

During the latter part of World War I, the American University research group investigated a new approach involving the control of viscosity independently of vapor pressure. It was reasoned that if a very high viscosity material were used to thicken gasoline, only a small percentage of thickener would be required, and, accordingly, the vapor pressure would not be affected markedly. The war ended before this work advanced much beyond the laboratory stage, and the thickening agent studied—sodium stearate—was not a happy choice. However, this basic approach laid the ground work for the successful development, during World War II, of thickened gasoline.

Among the first materials investigated as gasoline thickeners during 1941 was rubber. As little as 8% of crepe rubber was found to give excellent gasoline gels. Various methods were devised for the manufacture of this fuel. One consisted of the preparation of a concentrated solution of crepe rubber in benzene, which could be diluted with gasoline to give a final concentration of 8% rubber. Formulas utilizing crepe rubber or smoked sheet were standardized early in 1942. Shortly after this the major source of supply of rubber to the U. S. was cut off by the Japanese move into the East Indies. This action put the incendiary oil situation back to where it started. Work was started immediately on rubber substitutes. Buna S also was in short supply, but it was tried and found unsuitable. One of the Hycars also was investigated and found to be unpromising.

Attention was then turned to the work of the American University group on the sodium salts of various fatty acids. The method used at that time for forming these soaps was to dissolve the fatty acid in gasoline and then add alcoholic sodium hydroxide. This general method of thickening had been in use for a considerable period of time for producing lubricating greases. The gels produced by this method were not entirely satisfactory.

At about the same time an N.D.R.C. contractor investigated polymers other than the rubber types as gasoline thickeners. The most promising material found was isobutyl methacrylate polymer. It was found possible to produce good gels with this thickener. The isobutyl methacrylate polymer is still used as a thickener for the incendiary bomb fillings of the more complex types loaded with magnesium powder.

Under N.D.R.C. contracts, aluminum soaps were investigated as gasoline thickeners. In the preparation of aluminum soap lubricating greases, the soap and oil are heated until the soap is dispersed throughout the oil. A temperature of 150 to 230° F. is usually required. A temperature this high becomes impracticable with gasoline, particularly

for field mixing of gels. Emphasis was placed on seeking an aluminum soap which would gel with gasoline at room temperatures and give a stringy type gel.

It was found that a mixture of aluminum napthenate and the aluminum soaps of coconut fatty acids satisfied the basic requirements for a gel. This material was studied further with respect to large-scale manufacture. The formula was modified by the inclusion of oleic acid. The aluminum soaps of this mixture of acids was christened "napalm" from "nap" for napthenic acids and "palm" for the coconut fatty acids.

### Napalm

Napalm is the only standard thickener for preparing fuel for flame throwers and fire bombs. Therefore, it may be desirable to mention some of the more interesting characteristics of this material. Napalm is prepared by co-precipitation from a mixture of the sodium soaps of the acids. It is an off-white granular powder. Most of the napalm produced has been in accordance with one or the other of the following formulations:

| | *Original* | *New* |
|---|---|---|
| Coconut fatty acids | 50% | 30% |
| Oleic acid | 25% | 65% |
| Napthenic acid | 25% | 5% |

The new formulation resulted from a threatened shortage of napthenic acid which necessitated steps to reduce the requirements; however, almost all of the napalm manufactured has been of the original formulation.

of the moisture effect probably lies in the prevention of the formation or possibly the breaking of the soap chains by preferential coordination of water molecules at the points of attachment between the individual units. Osmotic pressure measurements indicates that the normal napalm in gasoline solution has a molecular weight of 160,000 to 200,000. It seems probable that these large molecules are built up largely by the coordination of the aluminum atom of each soap unit with a carboxyl oxygen of the next unit. Such chains obviously can be broken if a molecule to which aluminum coordinates more strongly than the carboxyl oxygen is introduced. This seems to be the case when water, amines, or free fatty acids of low molecular weight are added. The aluminum atoms coordinate preferentially with the amine or hydroxyl groups, the soap chains are broken, and there is a resultant drop in molecular weight and consistency.

Another problem was the deterioration of the napalm soap on storage due to oxidation. The unsaturated fatty acids and soaps of these acids present in napalm account for its oxidation susceptibility. The oxidation stability of the soap can be improved considerably by the addition of certain well-recognized oxidation inhibitors.

Impurities which may cause partial or complete breakdown of napalm gels include:

(1.) Excess water, lime or caustic soda.

(2.) Soaps of sodium, copper, lead, iron, manganese and cobalt.

(3.) Metallic zinc or lead.

n, the flame penetrates into an enclosure.

Portable Flame Thrower in action, attack on Japanese Bunker.

The gelling properties of napalm are highly dependent upon many variables in its preparation. The general reaction which takes place in the preparation of napalm can be illustrated as follows:

$$HR + Al_2(SO_4)_3 + NaOH \longrightarrow$$
$$Al(OH)R_2 + Al(OH)_2R + Na_2SO_4 + H_2O$$

The napalm consists primarily of the di-soaps of aluminum. The mono-soaps exist in small quantities but there is no evidence that the tri-soap exists in the mixture.

The manufacture of napalm was plagued with many difficulties. The greatest single problem was moisture. The high humidity of the summer months introduced problems which, during the early manufacturing experience, appeared unsurmountable.

Napalm is essentially a hygroscopic material analogous to gelatin or paper in its affinity for moisture. The water absorbed greatly affects the consistency of the gel formed when the solid soap is dissolved in gasoline. The cause

(4.) Rust preventives containing amines, alcohols and all acids.

One of the vexing problems was the lack of uniformity of napalm produced by different manufacturers. This lack of uniformity made it difficult to obtain reproducible results in the preparation of gels, particularly in the field. Different lots of napalm would differ not only in the consistency of a gel of a given formulation, but also in the rapidity of gelling and in the stability of the gels. These difficulties were partially solved by closer control over the manufacturing process.

### Preparation and Properties Napalm Thickened Gasoline

The napalm gels can be prepared by vigorously stirring gasoline while the napalm is slowly added. Stirring or agitation is continued until the napalm particles swell to the point that settling does not occur. This point is called the stir time of the fuel. Indications of the formation of a gel may appear immediately if the gasoline is warm. At temperatures below about 50°F the rate of gelation is

too slow to be practicable. On the other hand if the temperature is above about 95°F, and if relatively high percentages of napalm are used, the gel may form too rapidly to permit a homogeneous mixture. The initial appearance of the gel is somewhat similar to that of applesauce in that it has no stringiness or marked cohesive properties. Upon aging approximately 24 hours the gel becomes fully matured and acquires a homogeneous appearance. It also acquires the characteristic elastic properties.

The percentage of napalm used to form a gel varies depending on the intended application of the fuel. For portable flame throwers 3 to 5% normally would be used. For mechanized flame throwers, fire bombs and incendiary bombs the range of percentages would normally be from 6 to 13%. Napalm gel is a non-Newtonian material. This means that the viscosity of the gel varies with the rate of shear. This characteristic is of vital importance for flame thrower applications and will be discussed in more detail later under flame throwers.

The performance of a gel depends upon a combination of characteristics, but undoubtedly the most important of these is its viscosity. The two instruments which have been found most useful for viscosity measurements of gasoline gels are the Gardner mobilometer and the torsiometer. The mobilometer is most useful for gels in the medium viscosity ranges. This covers most of the flame thrower and fire bomb fuels but not the very viscous fortified fuels used in incendiary bombs. The torsiometer has been found to be the most generally satisfactory instrument for viscosity measurements of the very viscuous gels. Viscosity based on the Gardner mobilometer is expressed in grams Gardner and represents the weight required to force a perforated disk a distance of 10 cm. in 100 seconds through a closely fitting cylinder containing the gel. In the torsiometer, consistency is expressed in terms of minutes, and represents the time required for a paddle submerged in the gel to rotate through 360° when actuated by a fixed force.

It may be of interest to mention the effects of temperature changes on the viscosity of gasoline gels. In contrast to what might be expected, there is no fixed trend in the change of viscosity with temperature. With unpeptized napalm gels the maximum viscosity is reached at about 40°F. A typical 8% napalm gel gave consistencies in grams Gardner of 550 at 120°F, 750 at 40°F, and 600 at 0°. With peptized gels or gels produced by other type soaps, entirely different trends may be obtained.

The properties of napalm fuels are affected by the type of hydrocarbon or gasoline employed. Cyclic hydrocarbons tend to give high consistencies as compared to those of the noncyclic hydrocarbons. Gasolines which are likely to be available, generally give variations which are acceptable in field applications provided the gasoline contains no free water. It is possible to add relatively large percentages of less volatile fuels such as diesel fuel or fuel oil to gasoline without markedly altering the consistency of the gel resulting therefrom. For a given lot of napalm it has been shown that the temperature, the time of stirring and the degree of agitation are factors which have significant effects on the properties of the gel.

Peptization is a process which is sometimes used in preparing flame thrower fuels. The addition of peptizing agents such as cresols or xylenols to thickened fuels at the time of mixing produces several effects on the resulting gels. For a gel of a given percentage thickener, the addition of a peptizer results in the formation of a gel of lower viscosity and greater stringiness. The peptized gels are easier to pour which is an important factor when flame throwers are filled in the field by gravity methods. Another important feature of the peptizer is the appreciable reduction in the minimum temperature at which the gel will form. For example, it is not practicable to form napalm gels containing no peptizer at temperatures much below 50°F. However, by the use of 0.5 to 1% peptizer, particularly cresylic acid, it is possible to form gels at temperatures as low as 0°F.

### Flame Throwers

One of the most important applications of thickened gasoline is in the flame throwers. These weapons may be divided into two general classes. One of these classes is known as portable flame throwers which are designed for mounting on a man's back. The other class consists of the vehicular or mechanized types, usually having considerably greater range and capacity than the portable types.

### Technical Aspects

A flame thrower is a basically simple device for projecting a stream of burning incendiary liquid. The flame thrower consists primarily of a system for forcing the fuel from a nozzle at the necessary velocity, and a device for igniting the fuel as it leaves the nozzle. The basic simplicity of the flame thrower may not be apparent in the large capacity mechanized flame throwers.

The major development objectives have been to provide increased range, reliability and simplicity. Another important objective with respect to the portable units is to reduce the weight of the weapon.

The most important of the design variables which affect performance is the diameter of the nozzle. The diameter is about 5/16-inch for portable flame throwers and may be as large as 1 inch for mechanized types. The range increases appreciably as the nozzle diameter increases but the rate of range increase decreases as we get into the largest sizes. The range of a 5/16-inch nozzle under favorable conditions is about 40 to 60 yards while ranges well in excess of 100 yards may be obtained with nozzles having diameters of ½-inch and larger.

The type of fuel pressurizing system has no significant effect on the range provided that it is capable of maintaining the required pressure at the nozzle. The most commonly used pressurizing system utilizes compressed gases such as air or nitrogen. The compressed gas is stored initially at a pressure of 2,000 to 3,000 p.s.i. The high pressure gas is reduced by a regulating valve to the desired optimum operating pressure which may be from 200 to 450 p.s.i. depending upon the size of the nozzle and the consistency of the fuel. In most flame throwers the presurizing gas is in direct contact with the fuel. The rate of fuel discharge may vary from ½ gal. per second in the portable flame throwers to over 5 gal. per second in the larger mechanized flame throwers. Other pressurizing systems which have been used include pumps and burning powders such as cordite.

Quite a variety of ignition systems have been used on flame throwers. The portable flame throwers used initially in World War II used a hydrogen jet ignited by a high-tension electric spark. An undue number of malfunctions occurred with this system, particularly in the Pacific theaters. Accordingly, an improved flame thrower was developed and standardized which used a pyrotechnic ignition. Combat experience proved this system to be quite reliable. Most of the ignition systems for mechanized flame throwers are based on the ignition of a gasoline jet by a high tension electric spark.

The type of ignition system, provided it functions, has no effect on the range of the flame thrower if the rate of vapor release from the fuel rod is above a certain minimum. In other words, if the consistency of the fuel is sufficiently low and its temperature is sufficiently high to provide the required minimum rate of gasoline vapor release, there will be no difference in the range regardless of whether the ignition device consists of a simple match

or of a complex system giving a large amount of flame. From a practical standpoint this means that ignition is not critical during the summer months when the fuel is warm. However, during cold weather, ignition may become a serious problem since the rate of vapor release from a rod of cold fuel of rather high consistency may not be sufficient to maintain ignition of the rod. Under these conditions the amount of heat transferred from the ignition system to the fuel rod becomes an important factor. One solution to the problem of igniting high consistency fuel in cold weather is to use what is known as secondary fuel. This consists of injecting gasoline into the fuel just before it enters the nozzle. The result is a fuel rod sheathed with unthickened gasoline which volatilizes sufficiently rapidly to maintain ignition. The amount of secondary fuel used is about 3% of that of the main fuel. This system is used only on the larger types of mechanized flame throwers.

The most important operating variables are fuel consistency, temperature and pressure, and wind. For a given nozzle diameter, the operating variables are generally more important than the design variables in determining the range performance of a flame thrower.

Maximum range for a given flame thrower is obtained by using a fuel having the maximum viscosity consistent with good ignition. The very high viscosity fuels used by some of the larger mechanized flame throwers have the appearance of jello rather than that of a viscous liquid. The use of the high consistency fuels permits the use of greater nozzle pressure without rod breakup thereby giving greater ranges. It is essential that the rod remain ~~unbroken for~~ as long a path of the trajectory as possible. Once the rod is broken, the scattered gobs of fuel quickly fall to earth.

One item of considerable interest is the difference in ranges of an ignited fuel rod versus an unignited one. It will be found that if a flame thrower fires an unignited shot followed by an ignited one, the range of the ignited shot will be roughly twice that of the unignited shot. The ranges of poorly ignited shots are intermediate between the well ignited and the unignited ones. This phenomenon is not completely understood, but is probably due to a combination of factors such as changes in the density and viscosity of the surrounding air, updrafts due to the burning fuel, and possibly to jet effects due to the rapid formation of combustion gases. Ranges have been obtained at relatively low angles of nozzle elevation which were slightly greater than the calculated theoretical range in a vacuum.

It has been pointed out previously that temperature may be an important operating variable. The temperature of the fuel is considerably more critical than that of the ambient air. Some adjustment in the fuel consistency must be made to give optimum effects at a given temperature. For example a fuel which may be entirely satisfactory at 70°F. may not ignite at all at a temperature of -20°F. A lower viscosity fuel, with some sacrifice in range, must be accepted for use at very low temperatures.

The optimum fuel pressure or nozzle velocity is the maximum possible without causing excessive breakup of the fuel rod due to impact with the air. If pressure is increased beyond the optimum the range decreases. The optimum pressure varies depending upon a combination of factors such as fuel consistency, nozzle diameter and temperature.

The velocity and direction of the wind are important factors in determining the range of a flame thrower. As might be expected the greatest range is obtained when firing downwind. The range when firing into the wind or crosswind may be from ½ to ⅔ the downwind range.

It was mentioned previously that napalm-thickened gasoline is a non-Newtonian liquid. This characteristic is of vital importance for flame thrower applications. If the viscosity of the fuel did not markedly decrease when subjected to shearing forces, the frictional losses which would result when the fuel is forced through the piping system would be too great to be acceptable. A napalm gel having jello-like consistency in a static state, has a viscosity almost comparable to that of lubricating oil when it is forced at high velocity through pipes or pumps. As an example, a 6% napalm gel when flowing through a 1½-inch straight pipe at a rate of 0.03 gal. per minute had a pressure drop of 0.5 lb. per square inch per foot length of pipe and an apparent viscosity of 3800 poises. When the flow rate was increased about one thousand fold to 31 gal. per minute, the frictional losses increased only 20% and the apparent viscosity was reduced from 3800 to 4.7 poises. It likewise is fortunate that the napalm gel recovers its high viscosity almost instantly after the shearing forces are removed. If this were not the case, the fuel, when ejected from the nozzle, would be shattered by the impact with air.

### Operational Aspects of Flame Throwers

Flame throwers were used by the Germans in World War I with some initial success, but after the surprise effect wore off, it became almost suicidal to use the weapons and they were held in general disfavor. An M1 portable flame thrower was standardized by the U. S. in August of 1941, and several versions of mechanized flame throwers were developed early in World War II. However, there was a considerable lack of interest on the part of potential users. A change of attitude began in December 1942 as a result of the demonstration of the usefulness of the portable flame thrower on Guadalcanal. After repeated failures to neutralize a Japanese bunker during an operation on this island, the Marines finally resorted to flame throwers. After recovering from their surprise at the instantaneous success of this weapon, the Marines promptly went on to take other bunkers in the same manner. The use of the flame thrower in the Pacific theaters continued to increase, and it was eventually conceded to be an invaluable weapon, particularly adapted to the conditions of warfare which prevailed in that area.

Unlike the German who usually fought well but retreated when the situation became hopeless, the Japanese soldier usually defended his foxhole, pillbox or bunker to the death regardless of the odds against him. He constructed intricate and amazingly strong positions which were very difficult to neutralize by conventional means. No weapon proved so effective against this type of target as the flame thrower.

The flame thrower is both a casualty weapon and a psychological weapon. Its ability to succeed where other weapons fail is partly due to its ability to project lethal flames around corners. The firing of artillery into the mouth of a cave is usually ineffective in neutralizing the personnel occupying the cave. However, in many instances where artillery and other weapons failed in overcoming such resistance, the flame thrower was immediately successful. Likewise, the flame thrower is quite effective against small well camouflaged bunkers where general but not exact location is known. By covering the general area with flame, the camouflage is burned away so that the opening to the bunker can be seen.

The physchological effects of the flame thrower are quite important and in some instances may exceed its value as a casualty producer. Man appears to have an inherent fear of flame. The threat of flame caused many of the Japanese to abandon their positions who otherwise would have fought to the death against other weapons.

The vulnerability of the flame thrower operator has always been conceded as one of the major disadvantages of the weapon. By bitter experience it was found that the vulnerability of the operator could be reduced to a very acceptable degree by using the weapon as a part of a coordinated team. The team keeps the enemy under fire while the flame thrower operator approaches to within range of his objective. Smoke grenades are used to cover his approach when required. The use of thickened fuels has doubled or tripled the range of the weapon; thereby making it possible to fire effectively at greater distances.

Another solution to the problem of the vulnerability of the flame thrower operator is to mount a flame thrower in an armored vehicle such as a tank. The greater weight permissible for the flame thrower when mounted in a tank permits markedly greater fuel capacities and ranges. Two general types of mechanized flame throwers were used by the U. S. in World War II. One of these was a so-called auxiliary flame thrower which could be mounted in standard tanks without sacrificing the normal armament of the tanks. These weapons had fuel capacities up to 50 gal. and ranges of about 60 yards. The other type of mechanized flame thrower consisted of a tank converted to a flame throwing vehicle whose primary mission was to project flame. The sacrifice of the normal armament of the tank permitted fuel capacities in excess of 200 gallons and ranges above 100 yards.

The general acceptance of the mechanized flame thrower occurred after the acceptance of the portable types. Although there was considerable development activity on the mechanized types of flame throwers during the early part of the war, no requirements were expressed by the potential users. The first indication of a requirement came from the Southwest Pacific Theater where troops improvised a mechanized flame thrower by mounting a portable flame thrower in a manner such that it could be fired from inside a tank. Prior to the receipt of an actual requirement from any of the theater commanders, a decision was reached in 1944 to procure 20 flame thrower tanks. Before these units could be produced, the Pacific Theater of Operation became more and more convinced that the mechanized flame thrower was of major importance. This opinion developed into an urgent requirement as the result of the use of large capacity flame throwers at Peleliu, which was the first combat use by the U. S. of a large capacity flame thrower. Twenty of these flame throwers were manufactured in 1944 at the request of the Navy for use on landing craft. They were never used for their intended purpose but were mounted on amphibious tracked vehicles and used for land fighting. Although the vehicles were entirely unsuited for this role, the flame throwers were highly successful.

Since mechanized flame throwers could not be supplied to the theaters at that time, a program was set up on the Hawaiian Islands to construct flame throwers from whatever materials were available. Chemical Warfare Service personnel stationed on the islands supervised the program, while most of the skilled labor was supplied by Navy Seabees. The first of these flame throwers was a Canadian unit modified to be mounted as the main armament of a light tank. These were used successfully on Saipan. Another version of a main armament flame thrower based on the medium tank was constructed on the islands. These units were used in small numbers on Iwo Jima, and in larger numbers at Okinawa. In fact the only relatively large-scale use of mechanized flame throwers by the U. S. was on Okinawa. The 713th Tank Battalion was converted to an armored flame thrower battalion at Oahu. This unit was equipped with the flame throwers constructed at Oahu, and played an important part in the operations on Okinawa. The battalion accounted for over 4,000 Japanese casualties with negligible losses of its own.

In the European theater the U. S. make only limited use of flame throwers, although the British and Canadians made rather extensive and successful use of mechanized flame throwers. The British were equipped with armored trailer type flame throwers towed by tanks. The Canadians used a somewhat smaller capacity flame thrower mounted in the lightly armored Bren gun carrier. The Canadians found that their lack of armor was compensated for to a considerable extent by mobility, low silhouette, and the principle of employment in mass.

The small capacity auxiliary type mechanized flame throwers were used by the U. S. in both the Pacific and European theaters. The troops had a general preference for the large capacity main-armament flame throwers with their greater ranges.

There was some initial resistance in the field to the use of thickened gasoline as flame thrower fuel. This was due in part to the less spectacular appearance of the thickened fuel and in part to the difficulty of obtaining reproducible napalm thickened fuels. Scientifically conducted tests during the latter part of the war demonstrated the value of thickened fuel in attacking embrasures. The unthickened fuel was found to be relatively ineffective at ranges greater than about 10 yards. It also was demonstrated that a smaller amount of medium viscosity fuel is required to produce a given lethality effect inside a bunker or pillbox than is required by a high viscosity fuel.

The physiological effects of flame are varied. In some cases, victims were found dead without any apparent bodily damages. Death may be due to the cumulative effects of several factors in addition to heat, such as decreased oxygen, noxious fumes, excitement, etc. It sometimes is erroneously stated that death is caused by suffocation due to depletion of oxygen by the flames. This obviously cannot be the sole cause of death since a man can survive for some time in an atmosphere containing less oxygen than is required for combustion of gasoline.

Considerable effort has been devoted to devising protective measures against flame throwers. Apparently, the only practicable passible measures are to keep the flames from entering inclosures by the use of tight doors. However, it is not particularly difficult to force open such doors by weapons which are used in conjunction with the flame throwers. The only truly effective defense against flame throwers is to prevent them from getting within range.

### Fire Bomb

The fire bomb is a tactical weapon which frequently has been referred to in the Korean War as the napalm bomb. This bomb is primarily an anti-personnel or antitank weapon and should not be confused with incendiary bombs. The idea of the fire bomb originated from combat reports describing how partially filled jettisonable gasoline tanks were dropped by homeward bound low flying planes, and then ignited by tracer ammunition. The improvised fire bomb was improved by using thickened gasoline to provide better target effects, and by white phosphorous-filled igniters which functioned on impact with the ground. The most commonly used fire bomb in World War II was based on the 165 gal. jettisonable gasoline tank. The fire bomb is used primarily by fighter aircraft. The bomb is usually released at low altitudes. The jellied gasoline is scattered by the impact of the bomb over an area roughly half the size of a football field. The fuel is ignited immediately by two igniters. The fire bomb has been found to be one of the most important antitank weapons used in the Korean War. Part of the effectiveness of the fire bomb is due to

the relatively large area it covers. This permits tanks to be knocked out by near misses. Approximately 37,000 fire bombs were dropped during World War II.

### Aircraft-Mounted Flame Thrower

Before going on to the incendiary bombs, it may be of interest to mention the development of an airplane-mounted flame thrower for ground strafing. Certain British individuals were highly enthusiastic over the idea and persuaded the U. S. to undertake development in 1944. The general concept was to mount a flame thrower in the bomb bay of a light bomber which would swoop down low and spray burning thickened gasoline over concentrations of troops. The unit finally developed had a capacity of 200 gallons which was discharged in one shot through a nozzle projecting from beneath the plane. The load of fuel was discharged in a few seconds by the pressure produced by burning powder. The effect was spectacular to say the least. During the discharge the rear of the plane seemed to be in flames. Although a considerable portion of the fuel reached the ground before being burned, the whole idea was quickly dropped in favor of the fire bomb.

### Incendiary Bombs

The effectiveness of incendiary bombs was demonstrated early in the war by the German attacks on England. The Germans used a 2-lb. magnesium bomb. The U. S. developed a 4-lb. magnesium bomb based on a British design. Production of the bombs had hardly begun before it became apparent that the supply of magnesium would not meet vital war requirements. To circumvent this shortage a steel-cased thermit-filled bomb was developed by the Chemical Warfare Service and used by General Doolittle in his historic raid on Japan.

In the meantime, the N.D.R.C. in cooperation with the Chemical Warfare Service investigated the feasibility of using petroleum-filled incendiary bombs. Out of this investigation came the famous 6-lb. M69 bomb utilizing a napalm-thickened gasoline filling. Three-quarters of a million clusters of these bombs were dropped on the cities of Japan. Reports of the Strategic Bombing Survey indicate that two months before Japan's surrender, incendiary bombs had already wrecked her war economy. Approximately 40% of every city subjected to incendiary bombing was destroyed. Because so much of Japanese war industry was in homes, the war potential was seriously crippled by the mass destruction of urban areas.

The M69 bomb consists of a thin-cased steel body filled with a high-consistency napalm gel. The bomb is stabilized by cloth streamers so that it will impact nose first and penetrate most room structures. After penetration, the gel is ejected in an ignited form from the tail end of the bomb. The gel is ejected with considerable force and if unobstructed has a range of as much as 50 yards. A charge of white phosphorus is included in each bomb to produce a dense white smoke to hinder fire fighters. Before the end of the war the M69 bomb was modified to include an explosive charge with a variable delay as an additional hazard to fire fighters. These were not used operationally however due to delays in their development and manufacture.

An entirely new bomb along the general lines of the M69 was developed to overcome some of the shortcomings of the M69. The new bomb weighs about 8 pounds and was standardized as the M74 incendiary bomb. The major changes were the inclusion of an "all-ways" fuze and a metallic collapsible tail. Another change was the use of gel loaded with magnesium powder and other ingredients. Although the M74 bombs were placed into large-scale production early in 1945, they did not arrive in the Pacific theater in time to be used.

In addition to the small cluster type incendiary bombs there were two types of larger incendiary bombs which were used extensively in World War II. One of these is the 100-lb. M47 bomb having moderate penetration. The other one is the 500-lb. M76 bomb which was designed to penetrate heavy industrial roof structures. Both of these bombs use a central burster for bursting the bomb casing and dispersing the incendiary gel.

The great shearing forces to which incendiary fillings are subjected in central burster type bombs present considerable problems. The highly non-Newtonian characteristics of napalm gels which are so essential to flame throwers, make these gels unsatisfactory in bombs of this type due to excessive atomization of the fuels. Another type of incendiary mixture known as PT-1 is generally used for these applications. PT-1 is a "loaded" petroleum fuel. The major petroleum consistent is gasoline thickened with isobutyl methacrylate. Metallic magnesium is added in the form of very fine particles dispersed in an asphalt-like material. This magnesium-asphalt mixture is commonly referred to as "goop." The PT-1 fuels are capable of withstanding severe shearing stresses and give good incendiary effects.

Incendiary bombs became the largest single class of supplies in the Chemical Warfare Service production program and one of the most vital factors in World War II in both the European and Pacific theaters. In the attack of urban and many types of industrial targets, and incendiary bombs were demonstrated to be superior to high explosive bombs.

Burst of 150-gal. Fire Bomb

## SCIENTIFIC REGISTER

*(Continued from Page 16)*

obtained from individual scientists will be recorded in such a manner that the system will lend itself to whatever type of placement or distribution program might be required in an all-out mobilization effort, should one occur. However, as the nation is thrust into an all-out war, it is inevitable that the National Scientific Register will play a significant role in many plans that may be adopted for allocating the scientists of America to critical war activities. With this eventuality over the horizon, it is vital to know in advance in as detailed terms as possible just who our scientists are, where they are, and what they can do. Since the total supply is limited, it is inevitable that shifts will have to be made from less essential to more essential work. With a foreknowledge that the enemy in the total war would have superiority in terms of sheer manpower, our hope for salvation must rest in the skills of our labor force. To assure that these skills will be most effectively used, we must know what the skills are and plan in advance for their most effective utilization in the national interest.

Chemical Command Summer Employees—Budding Scientists

## HELL BOMBS AWAY

*(Continued from Page 11)*

from the Manchurian-Siberian mainland. Whatever is the outcome of these setbacks, future historians, when dealing with specific weapons along with the ingenuity and courage of the fighting UN soldier, will not fail to pay tribute to the Chemical Corps and its Napalm. For, during the first five months of the conflict, the North Koreans were soundly beaten by a smaller force through the well-coordinated use of this simple weapon with the other weapons of war and the gallantry of the American and other UN soldiers.

With the entry of the Chinese Communistic hordes into the conflict, the entire picture has taken on a new aspect. Perhaps the "hell bomb" will continue to be its most highly effective destroyer, or perhaps some other Chemical Corps development will capture the spotlight and bring glory to the technical service whose working theme is "We Must Always Be Prepared." The Corps' position is well summed up in a recent letter from Colonel DeLancey King, Chemical Officer for the Far East Command, when he says, "So, in Korea, as throughout World War II, the Chemical Corps places in the soldier's hands some of the most effective weapons of war."

# CHEMICAL CORPS PROMOTION FOR POLISH REFUGEE

Of all the soldiers promoted recently at Army Chemical Center, probably no one is prouder of his newly-won status than Sgt. Gustav J. Siedler.

For him, America and the United States Army have a very special meaning.

Siedler's promotion last week from corporal to sergeant marked another long stride on the road back from a decade of heartache and frustration under the yoke of European dictatorship.

Sgt. Siedler was born in Poland in 1921, and inducted into the Polish Army in 1939 when the Germans launched their eastward invasion.

His country overrun by the Nazis, young Siedler fled Poland and continued to fight the Germans as a member of the Polish-English Army until his capture in 1943.

Siedler was liberated by the Americans in 1944, and became attached to to the 575th U. S. field artillery battalion where he formed a close friendship with Pfc. William W. Christofferson of 2500 Magnolia Blvd., Seattle, Washington.

After the end of the war in Europe, Siedler learned that all members of this family had been sent to Siberia as Russian captives. He turned to his new friends in the 575th, and they responded.

Christofferson returned to the United States, where he and his father, Dr. O. H. Christoffersen, arranged for Siedler's entry into this country. They took him into their Seattle home, saw that he got a year and a half of schooling, and helped him enlist in the U. S. Army on Sept. 1, 1948.

Siedler has applied for United States citizenship and hopes to receive his final papers within six months.



# KOREAN EXPERIENCE TOLD BY CHEMICAL CORPS SOLDIER

A Chemical Corps soldier back from Korea after being wounded by the Chinese Communists says he believes United Nations Forces now are up against a much tougher foe—man for man—than they faced in the North Koreans.

PFC. Leo Kraft, of Saginaw, Mich., is recuperating at Valley Forge General Hospital, Phoenixville, Pa., from a serious chest wound inflicted by a Chinese Red with a Russian-made "burp" gun near Unsan, Korea, on Nov. 2.

He was the first member of the hard-fighting 2nd Chemical Mortar Battalion to return to Army Chemical Center—the Battalion's home station—from the Korea front. Kraft visited the Center recently on a pass from Valley Forge.

"There's no question but what the the Chinese are better fighters than the North Koreans," Kraft said. "They are more fanatic, yes, but they are also better trained and aren't so ready to surrender when they get into trouble."

The 23-year-old Kraft, who enlisted in the Army at San Francisco, Calif., in March, 1949, was assigned to the Military Police Detachment at Army Chemical Center in October, 1949, after receiving his basic training at Fort Ord, Calif., and attending the MP school at Camp Gordon, Ga.

He was transferred to the 2nd Mortar Battalion just one week before it left here for Korea last September.

The Battalion arrived in Korea in early October, and Kraft's outfit—Company A—was attached to the 11th Regiment of the 1st ROK (Republic of Korea) Division moving northward.

The company sustained its first casualties while crossing an open field north of the "MacArthur line" on Oct. 24, and Kraft himself was wounded in a surprise, early-morning attack by Chinese Communists who surrounded A Company in a rice paddy.

Kraft was moved to a hospital at Anjun, then to Pyongyang, and from there to Osaka, Japan. He also re-

*(Continued on Page 38)*



# BOOK REPORTS

ORGANIC REACTIONS. VOL. X. Roger Adams, Editor-in-Chief. New York: John Wiley & Sons, Inc., 1949. viii, 446 pages. $6.00.

Continuing this valuable series, Dr. Adams and his editorial staff present ten more comprehensive chapters giving the methods, modifications, examples of applicability, detailed descriptions of procedures, yields, and other data, together with references to the original literature pertaining to these important reactions. Following are the chapter headings in the present volume: The Synthesis of Acetylenes; Cyano-ethylation; The Diels-Adler Reaction; Quinones and Other Cyclenones; Preparation of Aromatic Fluorine Compounds from Diazonium Fluoborates; The Schiemann Reaction; The Friedel and Crafts Reaction with Aliphatic Dibasic Acid Anhydrides; The Gattermann-Koch Reaction; The Leuckhart Reaction; Selenium Dioxide Oxidation; The Hoesch Synthesis; and The Darzens Clycidic Ester Condensation. This book, like its predecessors, will save the busy organic chemist the time and trouble he would otherwise spend in surveying and evaluating the literature concerning these reactions.

QUANTITATIVE ORGANIC ANALYSIS VIA FUNCTIONAL GROUPS. Sidney Siggia. vii, 152 pages. New York, John Wiley & Sons, Inc. 1949. $3.00.

Here is a book of procedures, each one of which has been evaluated by the author in the laboratory using relatively simple techniques and standard quantitative laboratory apparatus in practically every case. It is the first book to be concerned solely with the determination of functional groups; a more satisfactory method for analyzing an organic compound than determining the elements present in the compound. Each procedure is presented as a working method, with reagents and apparatus described, directions for calculating the results, and references to the literature where appropriate. The book should prove to be a very useful manual in both industrial and university laboratories.

UNIT OPERATIONS. George Granger Brown and Associates. 612 pages. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1950. $7.50.

Twelve chemical and metallurgical engineers, all but one being on the faculty of the University of Michigan, have collaborated to produce a comprehensive treatise on the basic principles of unit operations. The format of the book is well adapted to an adequate presentation of the subject, since the extra large page size (8½ by 11 inches) permits the reproduction of charts and illustrations in much clearer detail than those found in books of the more conventional size. The subject is divided into four main parts: solids, fluids, separation by mass transfer, and energy and mass transfer rates. There are 38 chapters and 586 illustrations. The book is not only a text for students of chemical engineering, but it provides a guide for the practical engineer in the design, construction, and operation of any new process plant.

POCKET ENCYCLOPEDIA OF ATOMIC ENERGY. Frank Gaynor. 204 pages. Philosophical Library, 15 East 40th St., New York 16, N. Y. 1950. $7.50.

The book is a dictionary of nuclear physics and atomic energy and is a collection of brief explanations of concepts and terms used in this rapidly expanding field of science. There are more than 2,000 entries, together with numerous charts, tables, biographical sketches, and illustrations. A comprehensive table of isotopes, occupying 21 pages, gives the properties of all known isotopes. In addition, there are individual entries for every element as well as descriptions of electrical, magnetic, chemical, and physical units; important nuclear research laboratories, power plants, etc. Not only the scientist and engineer, but

the teacher librarian, student, and layman, will find this book useful.

INDIUM. DISCOVERY, OCCURRENCE, DEVELOPMENT, PHYSICAL AND CHEMICAL CHARACTERISTICS, AND A BIBLIOGRAPHY OF INDIUM (ANNOTATED), 1863-1949 INCLUSIVE. Maria Thompson Ludwick, 276 pages. The Indium Corporation of America, 60 East 42nd St., New York N. Y. 1950. $7.50.

Here is the most comprehensive collection of information on indium that has ever been published. The development of this metal from a laboratory curiosity to a commercially useful product makes interesting reading. The first 69 pages are devoted to the occurrance, physical properties, analysis, alloys, and chemical properties of indium and its compounds. The remainder of the book is taken up with the annotated bibliography. While this is organized in such a way as to facilitate locating references to the information required, a subject index would have added to the usefulness of the book.

## NEW BOOKS

The following books have been received by your editors and reviews of them will be published as space becomes available:

Aries, R. S., and Copulsky, W.: "Sales and Business Forecasting in Chemical Process Industries." Chemonomics, Inc., 400 Madison Ave., New York 17, N. Y. 132 pages. $5.00.

Aries, R. S., and Newton, R. D.: "Chemical Engineering Cost Estimation." Chemonomics, Inc., 400 Madison Ave., New York 17, N. Y. 109 pages. $5.00.

Cope, A. C.: "Organic Syntheses." Volume 30. John Wiley & Sons, Inc., New York 16, N. Y. 115 pages. $2.50.

Cork, J. M.: "Radioactivity and Nuclear Physics." D. Van Nostrand Co., Inc., 250 Fourth Ave., New York 3, N. Y. 2nd Edition. 415 pages.

Fuson, R. C.: "Advanced Organic Chemistry." John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. 669 pages. $8.00.

Glasstone, S.: "Sourcebook on Atomic Energy." D. Van Nostrand Co.. Inc., 250 Fourth Ave., New York 3, N. Y. 546 pages. $2.90.

Green, L. W. "The German Chemical Industry. A bibliography of the Chemical, Metallurgical, and Process Industries." Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C. 392 pages. $10.00.

Kosolapoff, G. M.: "Organophosphorus Compounds." John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. 376 pages. $7.50.

Kunin, R., and Myers, R. J.: "Ion Exchange Resins." John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. 212 pages. $4.75.

Patterson, A. M.: "German English Dictionary for Chemist." John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. 3rd Edition. 541 pages. $5.00.

Rossini, F. D.: "Chemical Thermodynamics." John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. 514 pages. $6.00.

Sigaud, L. A.: "Air Power and Unification." The Military Service Publishing Co., 100 Telegraph Bldg., Harrisburg, Pa. 119 pages. $2.50.

Sweet, J. B.: "The Price of Survival." Military Service Publishing Co., 100 Telegraph Bldg., Harrisburg, Pa. 230 pages. $2.85.

Tillotson, L. S.: "The Articles of War, Annotated." The Military Service Publishing Co., 100 Telegraph Bldg., Harrisburg, Pa. 408 pages. $3.00.

Whitehead, T. H. "Theory of Elementary Chemical Analysis." Ginn and Company, Boston, Mass. 233 pages. $2.75.

Whitehead, T. H.: "A Laboratory Manual of Elementary Chemical Analysis." Ginn & Co., Boston, Mass. 64 pages.

## SERGEANTS COMMISSIONED AT ACC

Ten sergeants at the Army Chemical Center this week donned the bars of commissioned officers as a part of the Army's manpower expansion program.

On the same Department of the Army order restoring the ten to their Organized Reserve Corps ranks, six men who had passed recent competitive examinations for warrant officer rank were also promoted.

However, for Franklin A. Reis of Reading, Pa., it was all a bit confusing. He was a master sergeant one day, a warrant officer the next day, and a captain a few days later—all within the space of ten days. Also a bit confused were the other members of the Post Plans and Operations staff to which he is assigned, who, in order to be sure of addressing Reis correctly, have been calling him "Master Sergeant, Mister, Captain Reis."

Also returning to their former wartime commissioned rank of captain were M/Sgt. James E. Davies, Chester, Pa.; M/Sgt. Louis P. Stephens, Fort Payne, Ala.; as first lieutenants—Sgt. Bradford E. Tyndall, Attleboro, Mass.; M/Sgt. William E. King, Durham, N. C.; Sgt. John Havlick, Chicago, Ill.; as second lieutenants—M/Sgt. Thomas J. Williams, Dundalk, Md.; Sgt. Walter W. Lepkowski, Syracuse, N. Y.; and M/Sgt. Rupert A. Price, Fieldale, Va.

Named warrant officers in four different career fields were: M/Sgt. Reis, and M/Sgt. Durwood L. Pate, Goldboro, Ala., in the Unit Administrator career field; M/Sgt. Charles P. Pannebaker, Altoona, Pa., Chemical General Supply field; M/Sgt. Richard E. Donnelly, Brooklyn, N. Y., Criminal Investigation field and M/Sgt. Arthur P. Berry, Beverly, Mass., Military Personnel field.

## KOREAN CONFLICT

*(Continued from Page 35)*

ceived treatment at hospitals in Tokyo, Hawaii and California before arriving at Valley Forge Nov. 22.

Kraft, son of Mr. and Mrs. Conrad Kraft of 2 S. Laun Court, Saginaw, was born at Follet, Texas, and attended Arthur Hill High School in Saginaw. He served as a cook aboard a merchant marine ship for four years before joining the Army.

Kraft plans to ask for reassignment to the MP Detachment here when he is able to leave the hospital for good.

## ROCKY MOUNTAIN ARSENAL

*(Continued from Page 15)*

received wide acceptance throughout the United States and in foreign countries as an outstanding chemical for the control of cotton insects, grasshoppers, and other agricultural pests. The demand for "aldrin" during the first year of its production exceeded the company's productive capacity. "Aldrin" has been approved by the U. S. Department of Agriculture for the control of certain cotton insects, chief among which is the boll weevil, and has also been accepted for the control of grasshoppers.

Facilities for the commercial production of "dieldrin" are now getting into operation, and it is expected that considerable quantities of this chemical will be available for the next insecticide season. "Dieldrin" has been proved especially effective for the control of various species of flies, lice, fleas, and mosquitoes and their larvae. The U. S. public health service, which has done a considerable amount of experimental work with this material, has indicated that it will hold a high place among insecticides used for the protection of public health.

Both "aldrin" and "dieldrin" are extremely potent to many insects at remarkably low dosages. As an example, the U. S. Department of Agriculture has approved the use of "aldrin" for early grasshopper control at applications of 2 ounces per acre in spray formulations and 3 ounces per acre in dusts. This compares with ¾ pound to 1½ pounds per acre for the older insect toxicants used for grasshopper control. The recommended dosage of "aldrin" for boll weevil control is 4 ounces to the acre of both dust and spray formulations. Over 2,000,000 pounds of "aldrin" were manufactured in the company's plant last summer and over 8,000,000 acre applications of "aldrin" insecticides were used for insect control. "Dieldrin" is even more powerful than "aldrin" and effective dosage rates for control of many insects are infinitesimal in comparison to those of the older insecticides. In addition to its high potency, "dieldrin" has long residual activity, its effectiveness lasting for many weeks under outdoor conditions.

In the event of an all-out war effort by the United States, the advantage of these two chemicals from a logistical point of view would seem to make their continued production at such a time a vital contribution to the war effort. Because of their highly concentrated nature, "aldrin" and "dieldrin" may be moved wherever need arises with a minimum burden upon transportation facilities. In this connection, it is interesting to note that neither "aldrin" nor "dieldrin" require critically short benzene in their production; chlorine, another chemical in short supply, is used sparingly both as a basic ingredient of manufactured "aldrin" and "dieldrin" and on a per acre-treatment basis due to the low dosage requirement involved in comparison with many other insect toxicants.

Chemical research holds a place of high importance at Julius Hyman & Company. There is nothing of a commonplace or routine nature in the work done in its research laboratory as witness two major products, "aldrin" and "dieldrin," that were discovered and developed there. Other compounds now in the preliminary testing and pilot plant stage of development promise to maintain the reputation that this laboratory has won for the originality and the outstanding quality of its achievements.

In addition to its own program of fundamental research, the company supports a research program by grants-in-aid in support of its products in colleges and experiment stations in many parts of the United States and Canada where suitable conditions for testing are to be found.

Julius Hyman & Company was a small organization of modest resources when it came to Colorado to begin operations in 1947. It made up in ability, enthusiasm, and a will to overcome obstacles what it lacked in size and financial backing. At that time, it consisted of a group of approximately 30 well-trained specialists, most of whom were stockholders in the new venture. This basic organization has remained almost intact, and in the intervening years has been greatly expanded.

It employs presently more than 400 people in its manufacturing, research, and sales efforts and is growing rapidly; thus, it is apparent that the company has become an important factor in the economic and scientific life of Colorado as a result of the number and quality of its personnel, substantial payroll spent almost entirely in the state, and the sharply increasing demand for its products which have received the highest recognition throughout the United States and in many foreign countries. Today, Julius Hyman and Company is probably the largest chemical industry in the Rocky Mountain region and one of the most important manufacturing companies in the Denver area.

Dr. Julius Hyman serves the company as President; General C. S. Shadle, Mr. Henry Degginger, and Mr. J. Newton Hall as vice-presidents; Mr. Robert L. Silber as secretary; Dr. Lloyd M. Joshel as treasurer; Dr. Rex E. Lidov as assistant director of research; Mr. Edward Despres as advertising manager; Mr. Alvin Grant as export manager; and Mr. Roy Miller as plant superintendent.

### Persolite Products, Inc.

In 1938, while Mr. H. O. Freudenberg was in the business of manufacturing rock wool, perlite ore was brought to his attention by Dr. Russell D. George, state geologist and professor of geology at the University of Colorado. Experiments and development were interrupted by war service and subsequent hospitalization at Fitzsimons of Mr. Freudenberg. In 1946, he and Leonard Marcus, also an ex-serviceman and civil engineer, worked out a process of converting perlite ore into plaster aggregate (perlite is a volcanic glass flow which has moisture entrapped in it. When crushed and subjected to heat, the particles expand to approximately 10 times the original size, puffing and popping much as wheat and rice).

In 1947, Freudenberg and Marcus formed a corporation in Colorado, signed a lease on December 15 for building 523 at Rocky Mountain Arsenal (renewable for one year on each September 15), and began the production of persolite, their trade name. In 1949, Marcus went to Illinois and set up an independent plant to produce persolite for the Mid-Western and Eastern Markets.

Among the products manufactured at this plant are: A plaster aggregate—processed from perlite ore which is used in place of sand in various wall plasters because of its light weight, insulating, fireproofing, and sound transmission qualities; an acoustical aggregate for sound proofing in which processed perlite, together with other ingredients, is mixed dry and which, when water is added, can be applied as plaster to ceilings or pre-cast or designed. Persolite concrete which is used for insulation for underground steam pipes (this is a new use which the company thinks may be extended to other fields); persolite prefabricated blocks for use in masonry (for giving insulation and fire retardant qualities in construction); persolite concrete for sub-floors in movie projection rooms, furnace rooms, and for radiant heating installations; a persolite aggregate for insulation between walls; and a persolite aggregate for use as a structural soil conditioner. Persolite can also be used as a filler in plastics, resins, and in filtrations.

# C H A P T E R S

### ROCKY MOUNTAIN CHAPTER NO. 1,

On 6 February 1946, the first chapter of the Chemical Warfare Association was organized at Rocky Mountain Arsenal and was then designated as "Rocky Mountain Chapter No. 1, Chemical Warfare Association, Denver, Colorado."

The commanding officer at that time was Colonel C. S. Shadle and it was through his own initiative and efforts, aided by Mr. E. C. Thompson, who was at that time Chief, Central Planning, Rocky Mountain Arsenal, that the first Chemical Warfare Association Chapter No. 1 was formed.

On 15 April, 1946, General A. W. Waitt arrived and a meeting was called of all members of Chapter No. 1. General Waitt then presented the official charter to the chapter president, Colonel John D. Tolman. At this time, there were 75 chapter members. By the closing of the charter membership on 17 August, 1946, this number had grown to 217 members.

During the next two years, the chapter continued on a limited schedule with very little activity due to the reduction in force of civilian employees, release of military personnel, and the return of many of the members to their homes in other states.

New life was given to the chapter on 20 December, 1948, when Mr. E. C. Thompson was elected president and an able assistant, Major Russell Tegnell started a campaign to recruit new members. On April 12, 1950, at a dinner meeting held at the officers' club, Rocky Mountain Arsenal, Major Tegnell was presented with a plaque from the Association for securing over 25 new members and was further commended for his outstanding service to Chapter No. 1.

In April 1950, Lt. Col. Donald P. Smith, U.S.A.R., Cml. Corps, was elected president of Chapter No. 1. He immediately started a campaign to obtain various group memberships from some of the local Denver industrial firms. This resulted in obtaining two group memberships, Shwayder Bros., Inc., and Gates Rubber Sales Division, Inc. Both of these firms had completed many contracts for the armed forces in World War II.

The fall meeting was held on 4 October, 1950, with an attendance of 108 members, at which time the above firms were presented with their group membership plaques.

At the present time, there are 126 members in the Chapter and it is expected, with the present membership drive on, that this number will more than double in the very near future. Plans are to continue holding meetings at least once a month and to engage outstanding guest speakers for these events.

### NEW YORK CHAPTER

The New York Chapter met on November 9 at the Beverly Hotel in New York City. The meeting was very well attended, with about 100 present. Guests included Lt. Col. Escude, representing the Army, Lt. Cmdr. Fox representing the Navy and Lt. Col. Ordway representing the Air Forces. Others present were Dr. Lawson, General Waitt, General Montgomery, who represented General Porter. General Montgomery was Air Chemical Officer in World War II.

Industry was very well represented, and there were many questions asked from the floor regarding the possibility of securing procurement contracts and how some of the "red tape" could be eliminated. These questions were answered by Colonel Escude and Commander Fox.

Mr. Willard Jacobs talked on Civil Defense, and his address was very interesting and extremely well received.

Edwin C. Kenton, Pres.

### BOSTON CHAPTER

The first Fall meeting of Boston Chapter was held at the Hotel Puritan on September 28th. Guest speaker was Dr. Walter E. Lawson, President of the Association.

After brief reports by Chapter Officers, Col. William E. R. Sullivan, Commanding Officer of the Boston Chemical Procurement District, stated that the Chemical Corps expected to be progressively more active. He extended a cordial invitation to all members to come to the District Office, meet the personnel, and learn what the Corps has to purchase.

Dr. Lawson talked briefly about the meeting of the Directors of the Association in Chicago. This meeting was attended by General McAuliffe, Chief Chemical Officer, and Admiral Snackenberg, Bureau of Ordnance, U. S. Navy. Among the subjects discussed at this meeting were:

(1) Clearance of National Directors and certain Chapter Presidents would be secured to permit discussion of classified material with Procurement Officers and properly accredited agencies.

(2) The Association has been in close cooperation with the Office of Naval Research and has given specific assistance in several instances.

(3) Civil Defense, in which several Chapters have already taken active part, is moving forward slowly and appears to be accepted by the public with considerable apathy except on the West Coast. Industrial members will be interested not only from the point of view of plant protection but as citizens in their respective communities.

(4) Forthcoming issues of the JOURNAL may be larger. The articles will all be original—no reprints or resumes of earlier published information will be included. Members are urged to write articles of interest and importance either on technical or general subjects.

(5) In order to increase the effectiveness of our Association, increased membership is needed. Chapters are asked to encourage present members to bring in new ones. Dr. Lawson personally has been very successful in increasing the number of group and sustaining members. Increased membership will mean increased circulation of

the JOURNAL, permitting wider advertising appeal and affording a better publication.

It is Dr. Lawson's belief that our Association can and should become a strong force in our over-all national defense organization. He is of the opinion that one of the most important gaps to be closed is the woeful ignorance of the particular problems of industry and the military, each by the other. It is suggested that this condition may be improved through joint meetings with discussion of selected phases of the problems of each group.

Chenery Salmon, Lt. Col., Cml.C.,USAR, Secretary

### WILMINGTON CHAPTER

The Wilmington Chapter held its final meeting for 1950 on November 16th with a dinner meeting in the Hunt Room of the Hotel Rodney.

We were fortunate in having Dr. Albert E. Lombard, Jr., of the Research and Development Office, Department of the Air Force, as our guest speaker. Dr. Lombard's subject was: "Air Force Research and Development," treating with the research facilities of the Department of the Air Force, the objectives of Air Force research and some of the results which have been obtained. Dr. Lombard concluded his talk with the showing of an interesting Air Force Research and Development film.

The meeting was called to order by Mr. Howard S. McQuaid, our 1950 Wilmington Chapter President, who submitted the names of candidates for 1951 offices. In accordance with the Chapter By-Laws, Dr. Richard E. Chaddock, Hercules Powder Co., our 1950 First Vice President, automatically succeeds Mr. McQuaid to the Presidency. The following candidates were elected by unanimous vote to the offices indicated:

First Vice President, Charles H. Carter, Jr., Atlas Powder Co.; Second Vice President, Roger W. Fulling, du Pont Co.; Secretary-Treasurer, Harry J. McCauley, du Pont Co.

Forty-two persons attended the meeting, including many new members and interested guests.

H. J. McCauley, Sec.-Treas.

### WASHINGTON, D. C. CHAPTER

On Monday, 27 November 1950, thirty-five members of the Washington Chapter, Armed Forces Chemical Association, gathered at the Army-Navy club for a luncheon meeting. Dr. James Boyd, Director of the Bureau of Mines, Department of the Interior, and Acting Deputy Administrator, Defense Minerals Administration, spoke on the subject of raw mineral supplies, utilizing graphic presentations. Several basic minerals were discussed as to their present availability in this country and estimated reserves, the amounts imported, and the plans for development and utilization of substitutes or lower grade reserves. The meeting was also honored by the attendance of two former Chiefs of the Chemical Corps (Chemical Warfare Service during their tenure), Maj. Gen. Amos A. Fries and Maj. Gen. Walter C. Baker.

R. Donald Rogers
Secy.-Treas., Washington Chapter

# CHEMICAL CORPS KEY PERSONNEL

OFFICE, CHIEF, CHEMICAL OFFICER, WASHINGTON 25, D. C.

Chief Chemical Officer, Maj. Gen. Anthony G. McAuliffe

Deputy Chief, Brig. Gen. E. C. Wallington, Cml. C.

Chief, Personnel Div., Col. R. C. Benner, Cml. C.

Chief, Plans, Training & Intelligence Div., Col. J. C. MacArthur, Cml. C.

Comptroller, Lt. Col. J. J. Hayes, Cml. C.

Chief, Safety, Lt. Col. C. P. Holm, Cml. C.

Executive Officer, Major Floyd B. Mitman, Jr., Cml. C.

OFFICE CHIEF CHEMICAL OFFICER, ARMY CHEMICAL CENTER

Chief, Research & Engineering Div., Colonel William M. Creasey, Cml. C.

Asst. Chief Cml. Offr. for Materiel, Col. Henry M. Black, Cml. C.

ARMY CHEMICAL CENTER, MARYLAND

Commanding General, Brig. Gen. E. F. Bullene

Commanding Officer, Edgewood Arsenal, Col. E. Van Keuren, Cml. C.

Commandant, Cml. Corps School, Col. Frederick W. Gerhard, Cml. C.

Commanding Officer, Technical Command, Col. J. H. Rothschild, Cml. C.

President, Cml. Corps Board, Col. H. W. Rowan, Cml. C.

Chief, Medical Division, Lt. Col. M. W. Bayliss, M.C.

Chief, Cml. Corps Procurement Agency, Lt. Col. Carl S. Casto, Cml. C., Small Business Liaison, Mr. H. Parks

Commanding Officer, Edgewood Proving Ground, Lt. Col. Emory A. Lewis, Cml. C.

DESERET CHEMICAL DEPOT, TOOELE, UTAH

Commanding Officer, Col. R. T. Beurket, Cml. C.

Executive Officer, Lt. Col. K. A. Cunin, Cml. C.

DUGWAY PROVING GROUND, TOOELE, UTAH

Commanding Officer, Lt. Col. Donald E. Yanka, Cml. C.

Executive Officer, Major Elmer E. Dye, Cml. C.

PINE BLUFF ARSENAL, PINE BLUFF, ARKANSAS

Commanding Officer, Lt. Col. H. S. Markham, Cml. C.

Executive Officer, Major T. W. Rogers, Cml. C.

ROCKY MOUNTAIN ARSENAL, DENVER, COLORADO

Commanding Officer, Col. C. M. Kellogg, Cml. C.

Executive Officer, Lt. Col. David Armitage, Cml. C.

CAMP DETRICK, FREDERICK, MARYLAND

Commanding Officer, Col. Fred J. Delmore, Cml. C.

ATLANTA CHEMICAL PROCUREMENT DISTRICT, 114 Marietta St., N.W., Atlanta, Georgia

Commanding Officer, Lt. Col. W. L. MacLachlan, Cml. C.

BOSTON CHEMICAL PROCUREMENT DISTRICT, Boston Army Base, Boston, Mass.

Commanding Officer, Lt. Col. W. E. R. Sullivan, Cml. C.

CHICAGO CHEMICAL PROCUREMENT DISTRICT, 226 W. Jackson, Blvd, Chicago, Ill.

Commanding Officer, Lt. Col. Victor C. Searle, Cml. C.

DALLAS CHEMICAL PROCUREMENT DISTRICT, 1114 Commerce St., Dallas 2, Tex.

Commanding Officer, Lt. Col. George W. Dorn, Cml. C.

NEW YORK CHEMICAL PROCUREMENT DISTRICT, 111 E. 16th St., N. Y. C.

Commanding Officer, Lt. Col. J. F. Escude, Cml. C.

SAN FRANCISCO CHEMICAL PROCUREMENT DISTRICT, Oakland Army Base, Oakland 14, Calif.

Commanding Officer, Lt. Col. Hans S. Bendixen

CHEMICAL CORPS OFFICERS WITH THE ARMY FIELD FORCES

Headquarters, AFF, Fort Monroe, Virginia

Chemical Officer, Col. L. M. Johnson, Cml. C.

Headquarters, First Army, Governors Island, New York

Chemical Officer, Col. J. R. Burns, Cml. C.

Headquarters, Second Army, Fort George G. Meade, Maryland

Chemical Officer, Col. J. W. Mosteller, Jr., Cml. C.

Headquarters, Third Army, Fort McPherson, Georgia

Chemical Officer, Col. R. D. McLeod, Cml. C.

Headquarters, Fourth Army, Fort Sam Houston, Texas

Chemical Officer, Col. James M. McMillin, Cml. C.

Headquarters, Fifth Army, 1660 E. Hyde Park Blvd, Chicago 15, Ill.

Chemical Officer, Col. H. B. Bramlet, Cml. C.

Headquarters, Sixth Army, Presidio of San Francisco, Calif.

Chemical Officer, Col. S. E. Whitesides, Jr., Cml. C.

CHEMICAL CORPS OFFICERS RESERVE CORPS INSTRUCTORS

FIRST ARMY AREA

Capt. J. N. Klein, Office of Sr. State ORC Instructor, 90 Church St., New York City

Capt. R. G. Lynch, Office of Sr. State ORC Instructor, Kearny Shipyards, Kearny, New Jersey

THIRD ARMY AREA

Lt. Col. C. B. Drennon, Jr., Alabama Military District, 4th Fl., Calder Bldg., Birmingham, Ala.

Major E. Escudero, 1401 Hampton St., Columbia, S. C.

FIFTH ARMY AREA

Capt. G. E. Allard, 310 Federal Office Bldg., Third Ave. and Washington Ave., S. Minneapolis, Minn.

Maj. C. H. White, 12th and Spruce St., St. Louis, Mo.

Capt. V. Deptula, Michigan Sr. Army Instructor ORC, 463 Federal Bldg., Detroit 26, Mich.

THEATER CHEMICAL OFFICERS

EUROPEAN THEATER, Brig. Gen. C. E. Loucks, Chemical Div., Hqs. EUCOM (Rear), APO 403, c/o Postmaster, New York, N. Y.

FAR EAST COMMAND, Col. D. King, Chemical Section, GHQ, FEC, APO 500, c/o Postmaster, San Francisco, Calif.

PACIFIC THEATRE, Lt. Col. R. W. Breaks, Chemical Officer, US Army Pacific, APO 958, c/o Postmaster, San Francisco, Calif.

CARIBBEAN THEATRE, Col. R. E. Johnson, Box 477, Fort Amodor, Canal Zone

CHEMICAL CORPS ROTC INSTRUCTORS

Lt. Col. J. W. Fitzpatrick, 1180th ASU ROTC, Massachusetts Institute of Technology, Cambridge 39, Mass.

Lt. Col. M. A. Peerenboom, 2406th ASU, ROTC, The Ohio State University, Columbus 10, Ohio

Lt. Col. Walter W. Kuehler, University of Delaware, Newark, Delaware

Lt. Col. N. I. Decker, 3216 ASU, ROTC, Instructor, Georgia School of Technology, Atlanta, Ga.

Lt. Col. L. S. Moore, Military Dept., Texas A. & M., College Station, Tex.

Major Leon A. Keif, Military Dept., Purdue University, Lafayette, Ind.

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